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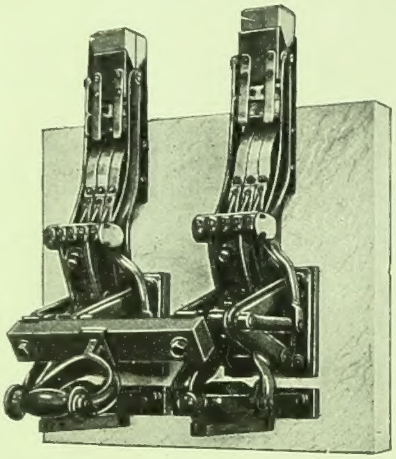

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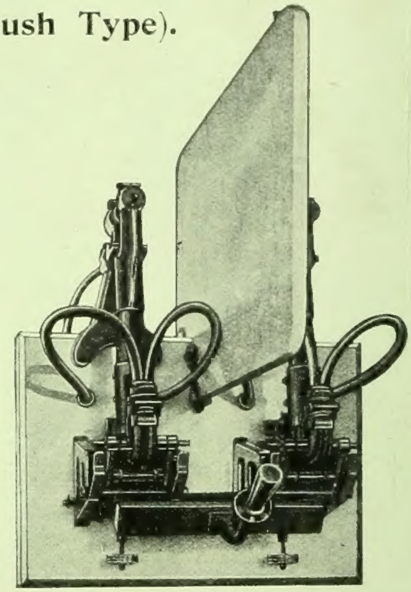

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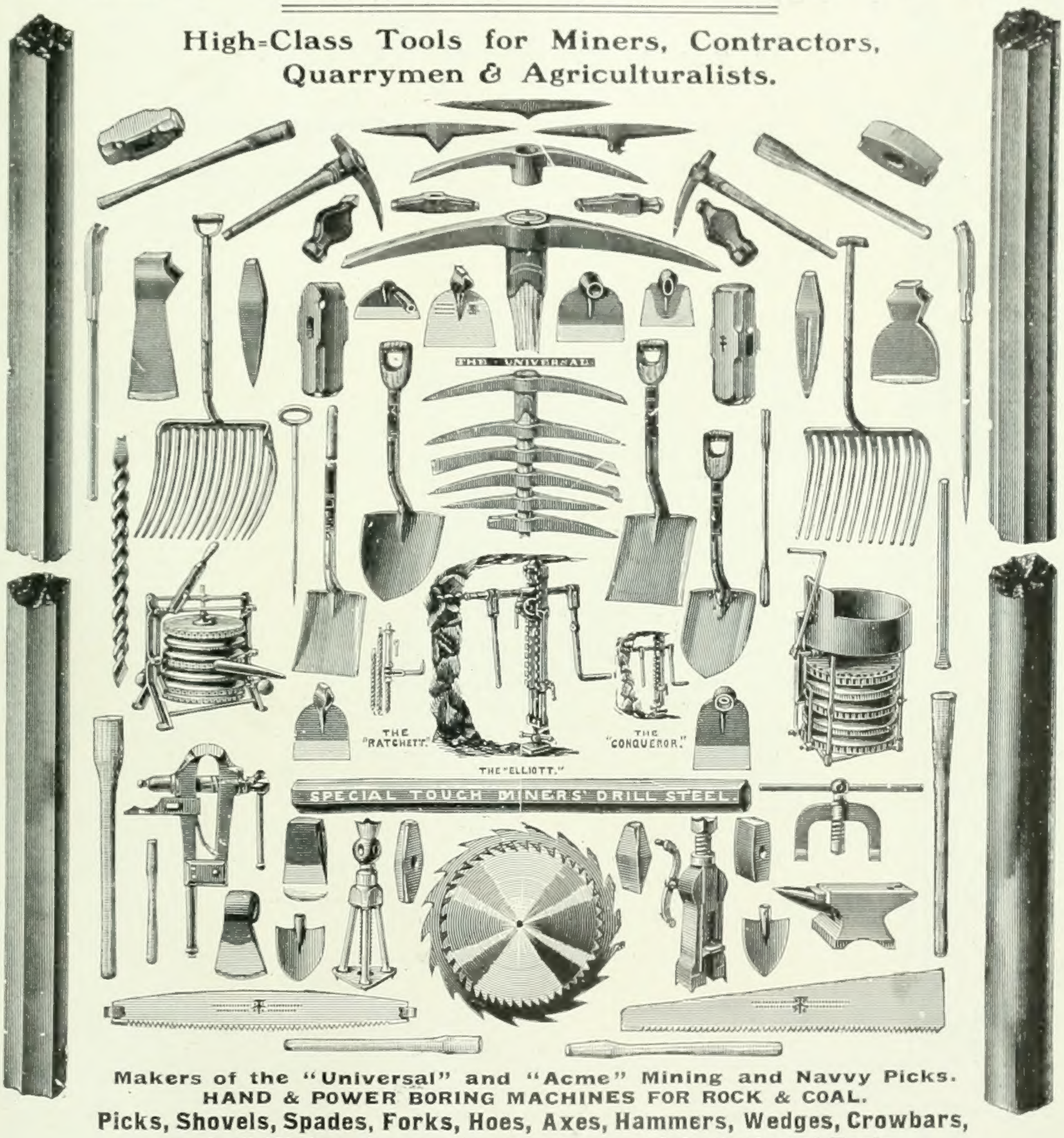
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CONTENTS

No. 5. MAY, 1903. Vol. II.

VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO NORTHERN ITALY . . . . . Frontispiece

THE RELATIVE IMPORTANCE OF OFFENSIVE AND DEFENSIVE QUALITIES IN MEN-OF-WAR Sir William Laird Clowes . 395

With numerous Illustrations, showing the various stages in the construction of a battleship.

In view of the progressive naval policy which is now before the country, and the prospect of a large expenditure on further additions to the British Navy, it seemed an opportune time to invite Sir William Laird Clowes—one of the leading naval experts of the day—to criticise the present tendencies of battle-ship construction. Other articles on kindred subjects which have appeared in PAGE'S MAGAZINE, are: "The Gun *versus* the Armour Plate" (October, 1902), and "The Distribution of Guns in Battleships" (January, 1903).

THE LODGE-MUIRHEAD SYSTEM OF "WIRELESS" TELEGRAPHY H. C. Marillier 410

With Twelve Illustrations.

Continuing the series of articles recently published in this Magazine under the heading "The Development of 'Wireless' Telegraphy," the Author now describes the system which Sir Oliver Lodge and Dr. Muirhead have been engaged for some years past in perfecting, and which has at length been put into practical working by the inventors. Sir Oliver Lodge's early work in connection with Hertzian waves and "wireless" telegraphy has already been described; but its later development, and especially the mechanical improvements due to Dr. Muirhead's experience of telegraphic work, have been kept back pending the completion of the whole system.

OUR MONTHLY BIOGRAPHIES 416

With Portraits.

Sir William Laird Clowes.
Mr. Michael Langridge, M.A., M.Inst.C.E., M.I.Mech.E.

NOTES AND NEWS. 418

Illustrated.

Washing Plant at the De Beers Mines.—The Uganda Railway.—The Miller Railway Signal System.—West's Patent 200-ton Commutator Press, etc., etc.

(*Continued on Page* 4.)

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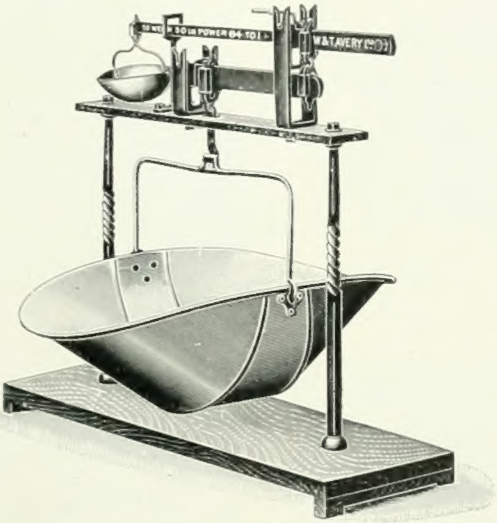

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CONTENTS

(Continued from Page 2.)

THE LAYING OUT OF ENGINEERS' WORKSHOPS.—III. With Seven Plans. The present article deals with the ground plans of works, and after setting forth his theories thereon, the Author describes the plans followed in laying out a number of typical establishments. The previous articles of the series appeared in the March and April issues.	**Joseph Horner**	**425**
LOCOMOTIVE ENGINEERING NOTES	**C. R. M.**	**436**
AMERICAN RÉSUMÉ		**439**
THE VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO ITALY With many original Illustrations from photographs taken *en route*.	**The Editor**	**441**
HIGH CAPACITY WAGONS	**One who does not believe in them**	**467**
FIRST AID TO THE INJURED IN MINING After an accident the danger to be apprehended to those who are severely injured depends in a measure upon the length of time which must elapse before medical aid can reach them. This period varies from a few moments to several hours, according to circumstances. During this interval of waiting what is to be done? In some instances nothing; in others prompt action must be taken to save life. The paper indicates the nature of this action in a number of specified contingencies.	**Dr. G. W. King.**	**468**
WORKSHOP PRACTICE A Résumé of Machine Tools, Cranes, and Foundry Matters for the Month. With Three Plans. New Turret Lathes.—The Practice of Crane Making.—Muscle *v.* Machinery, etc.		**473**
NAVAL NOTES Monthly Notes on Naval Progress in Construction and Armament.	**N. I. D.**	**477**
OUR MONTHLY RÉSUMÉ	**The Editor**	**480**
NOTABLE BRITISH PAPERS OF THE MONTH		**485**
SOME RECENT PUBLICATIONS		**495**
NEW CATALOGUES		**496**

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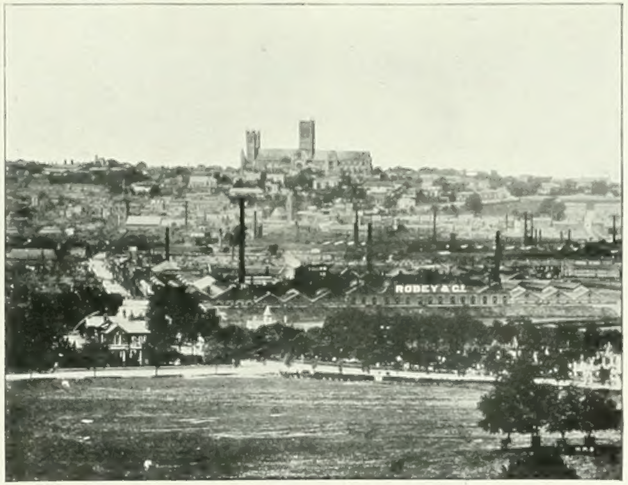

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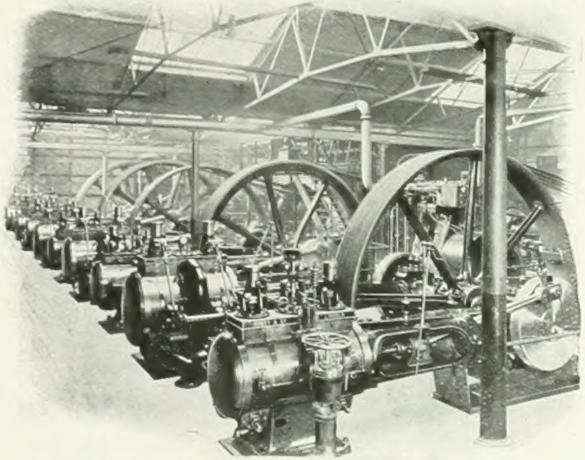

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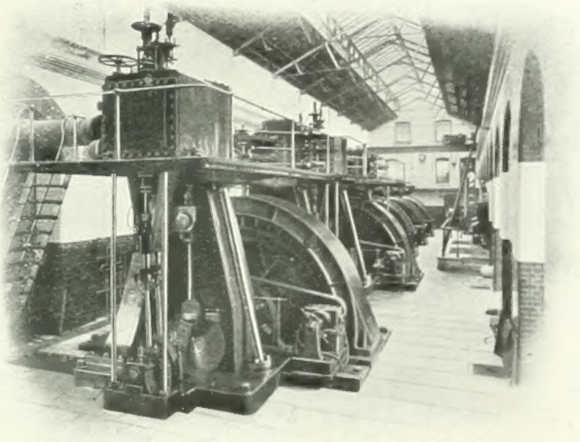

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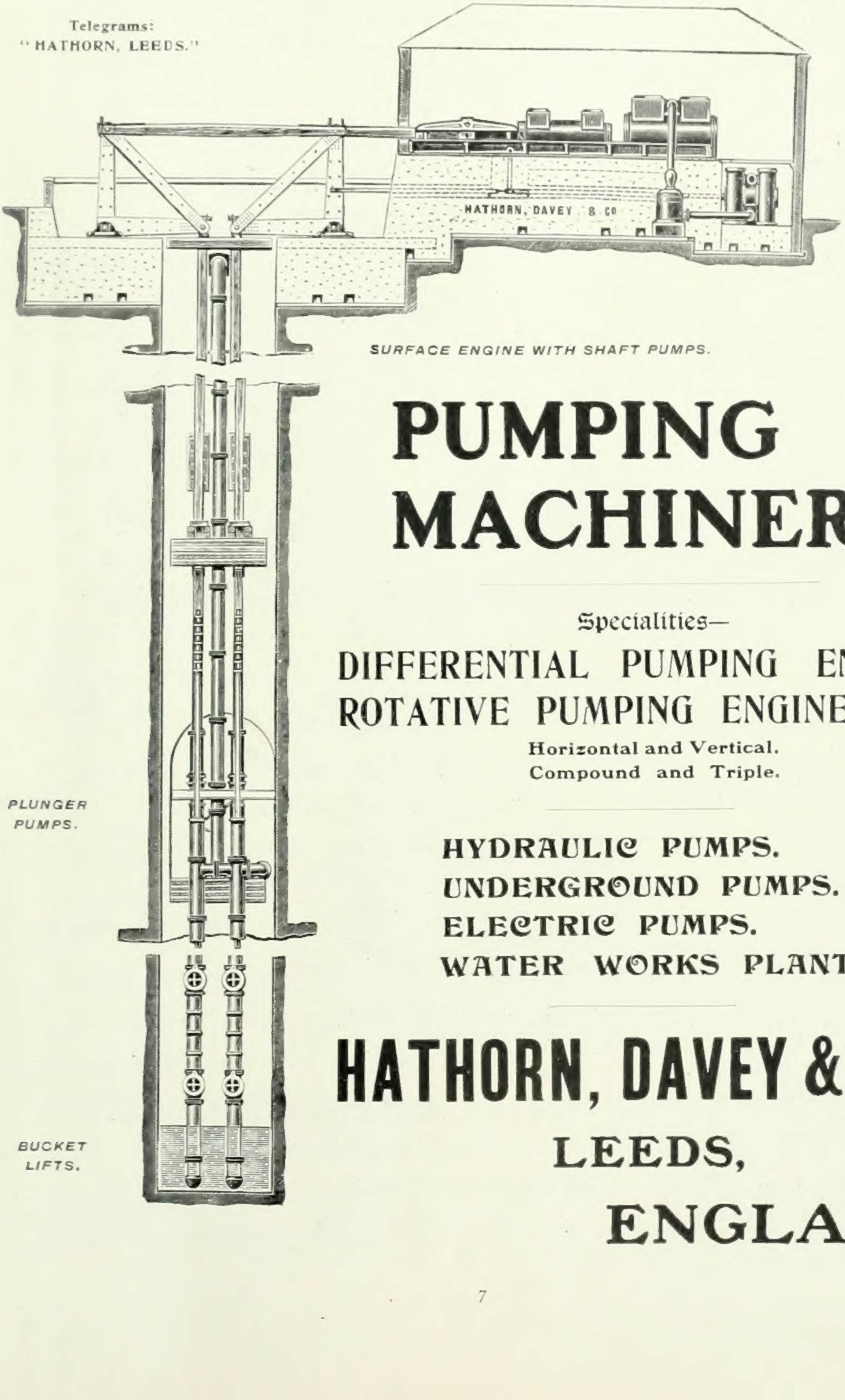

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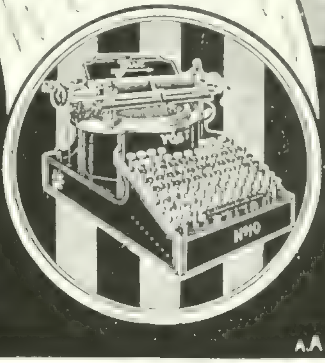

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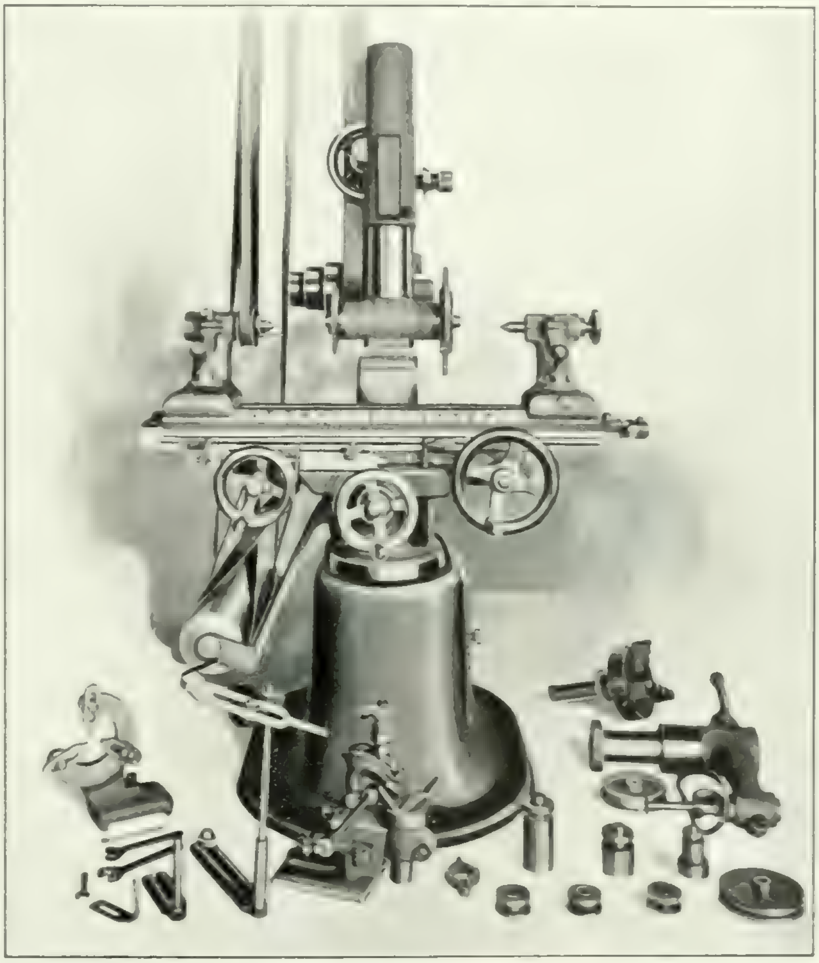

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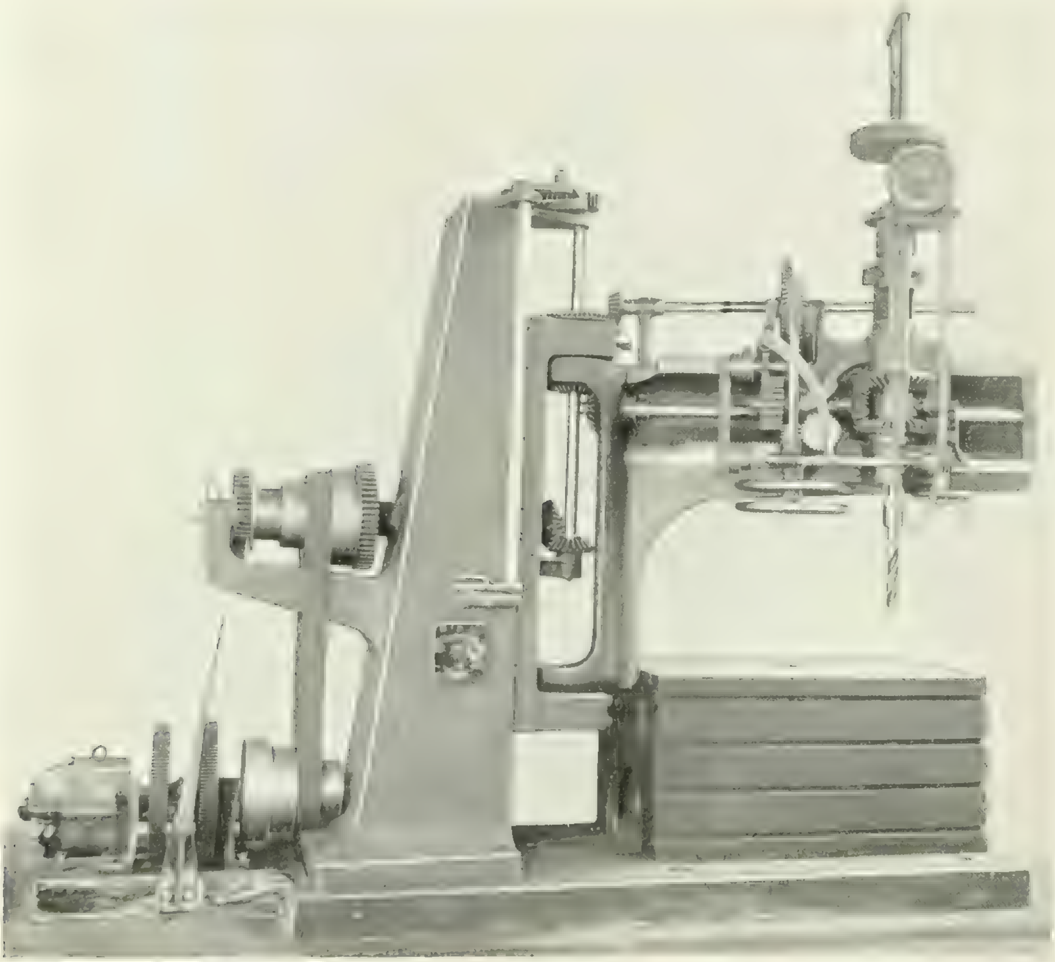

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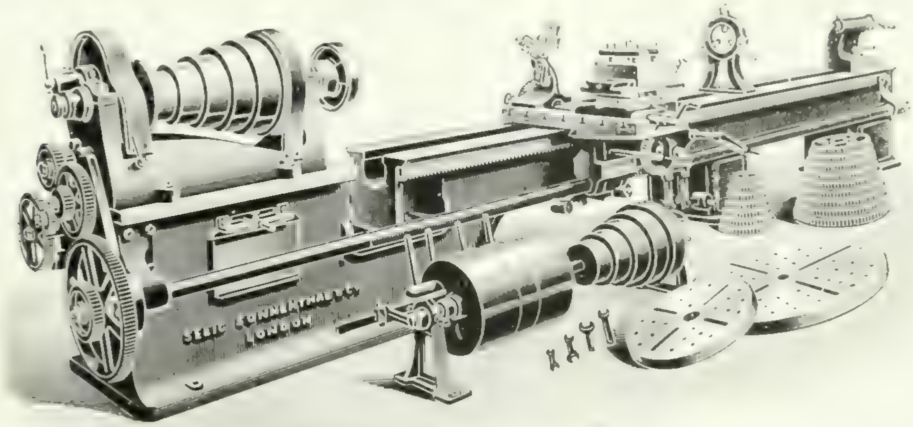

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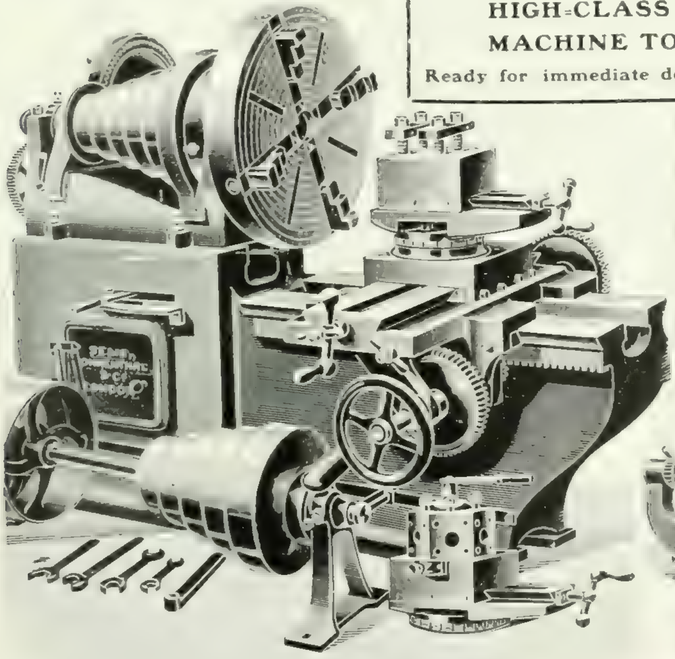

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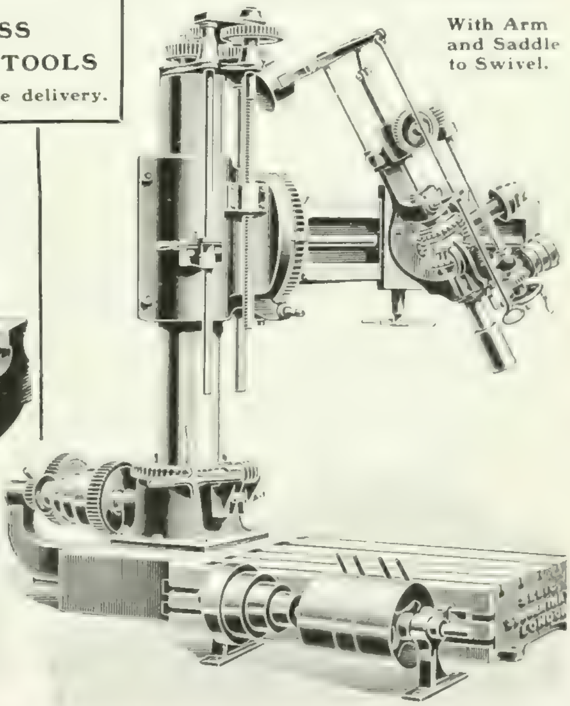

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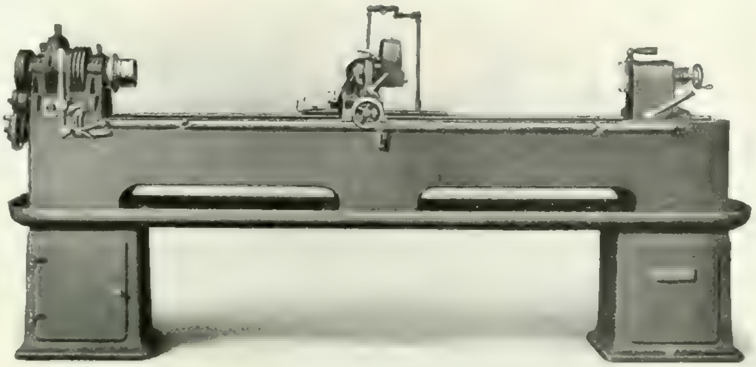

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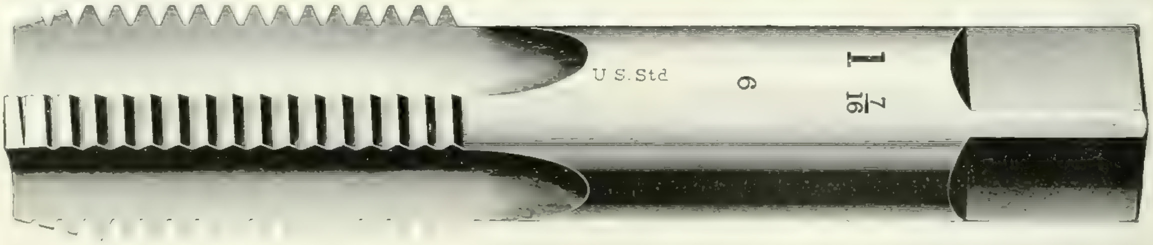

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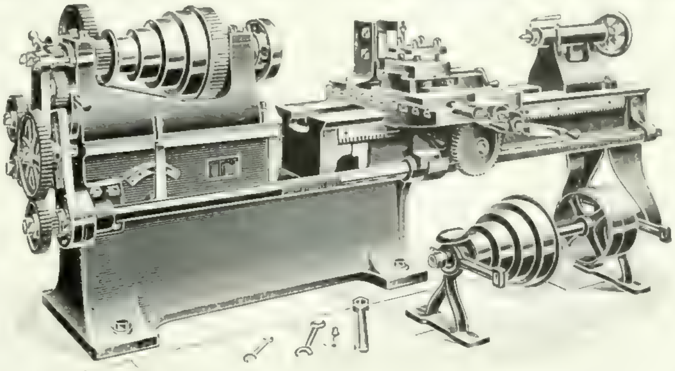

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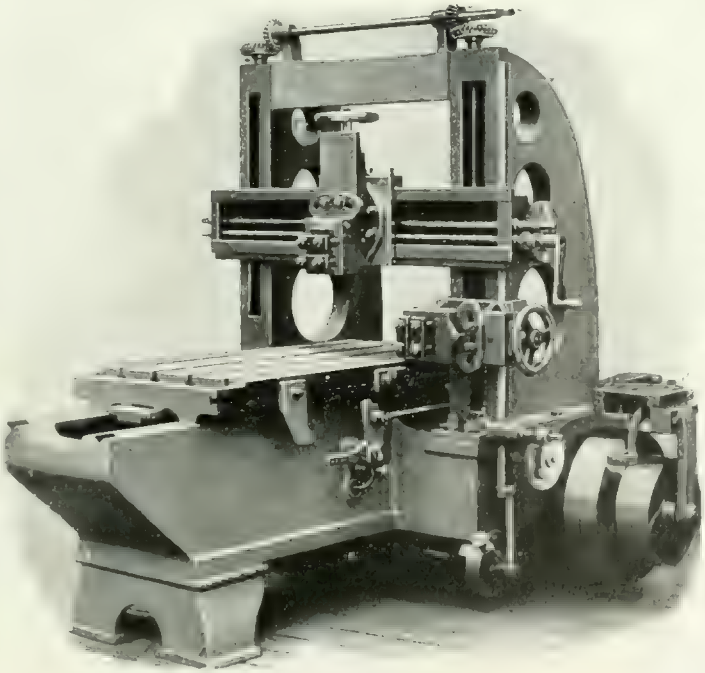

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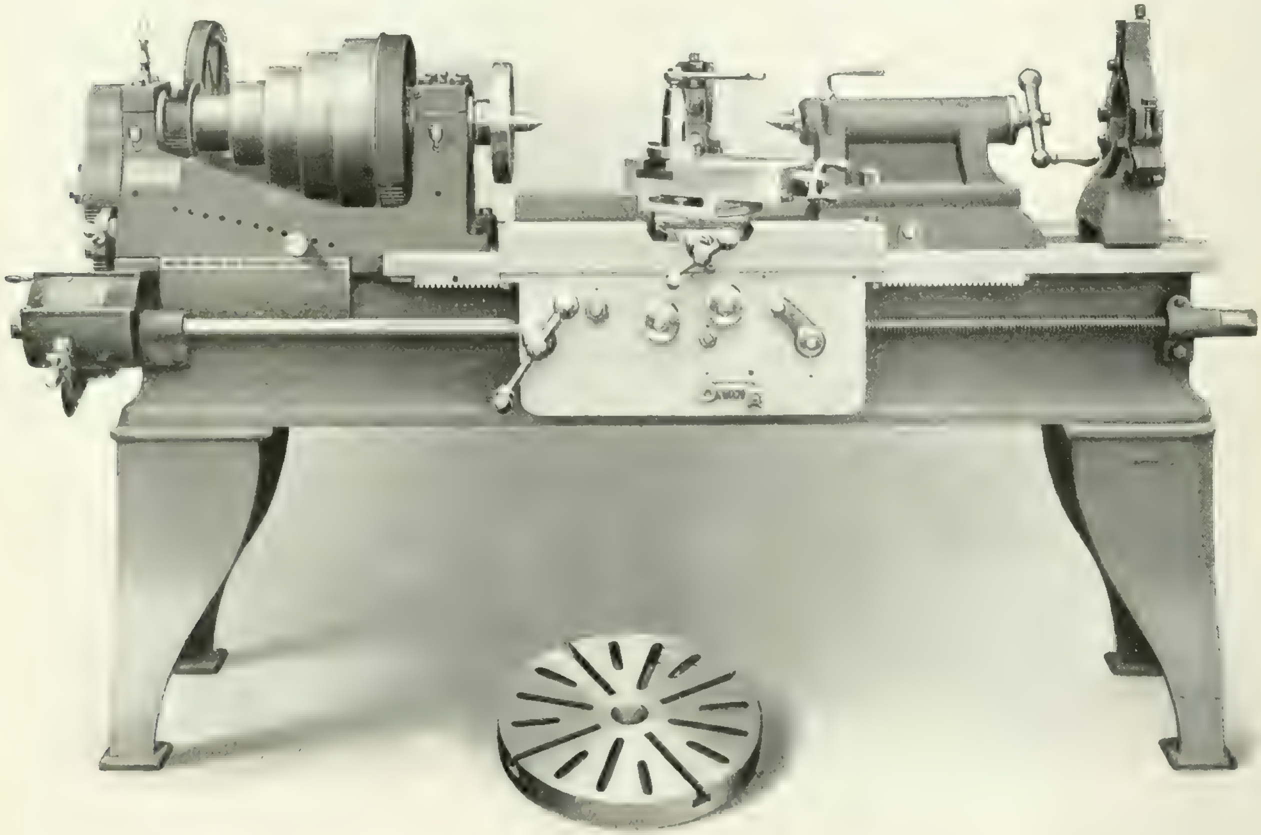

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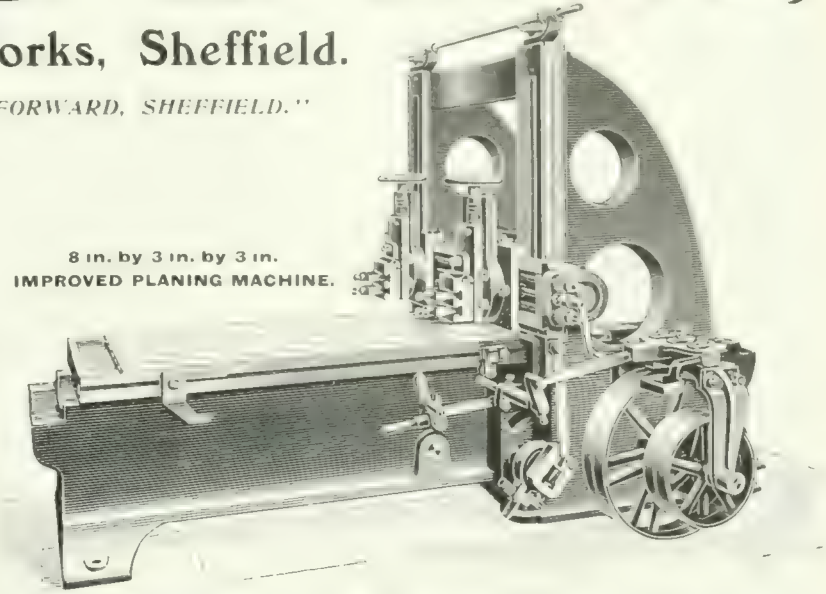

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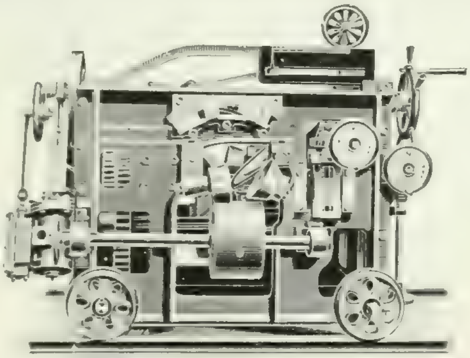

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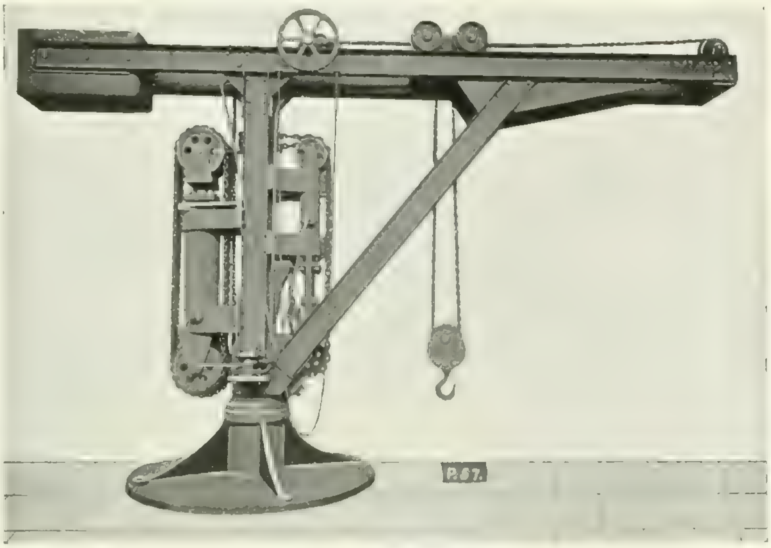

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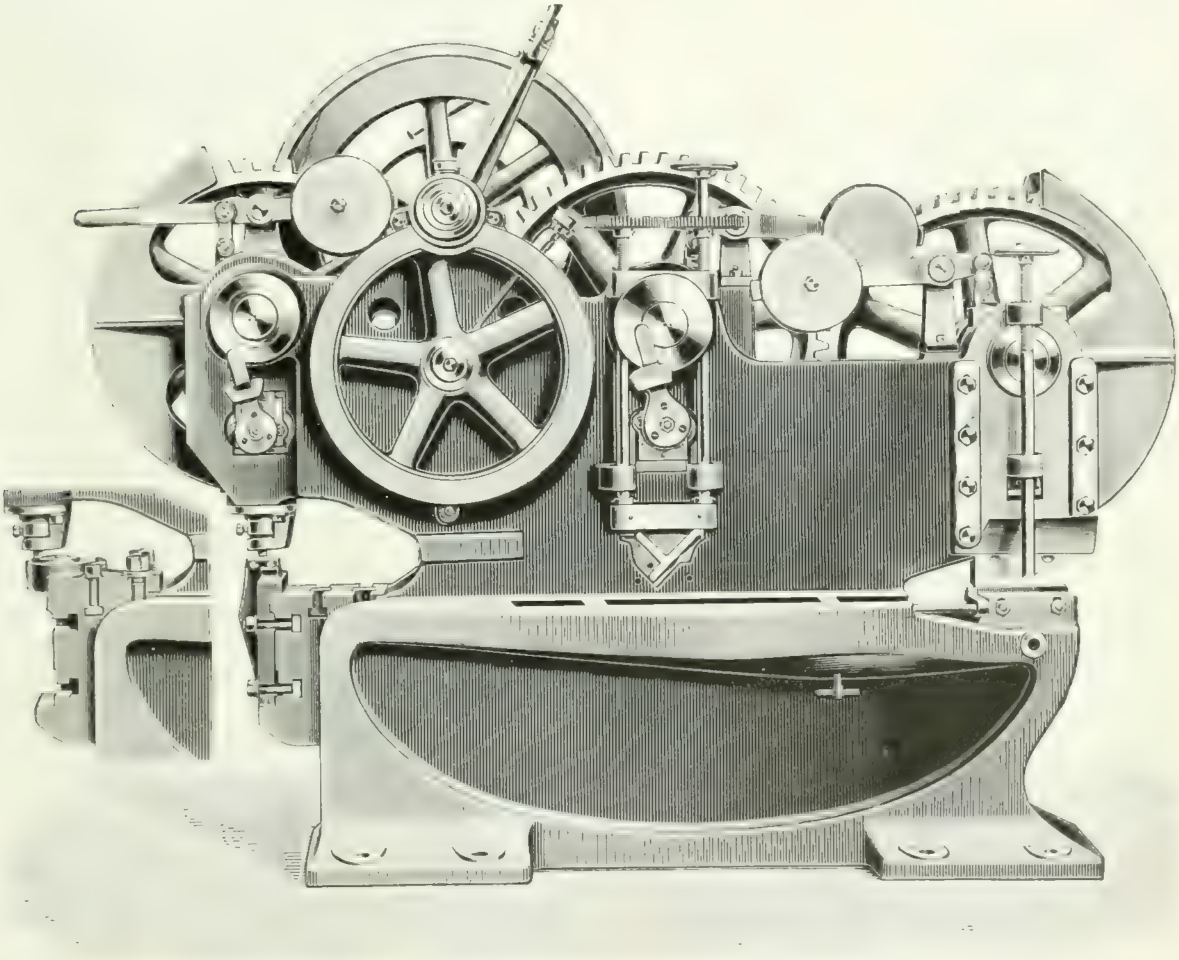

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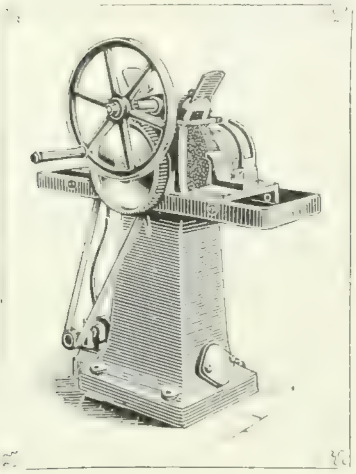

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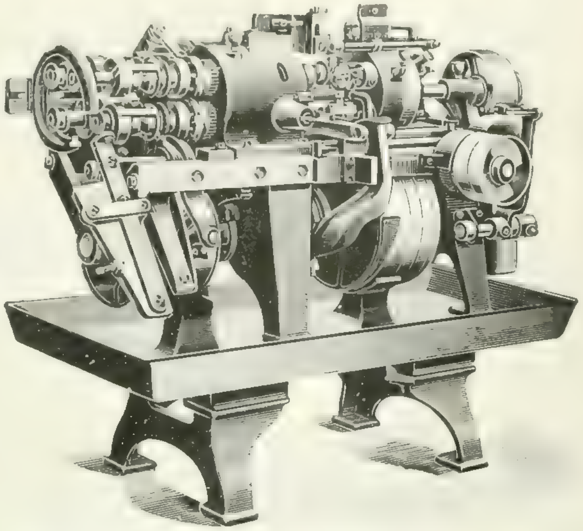

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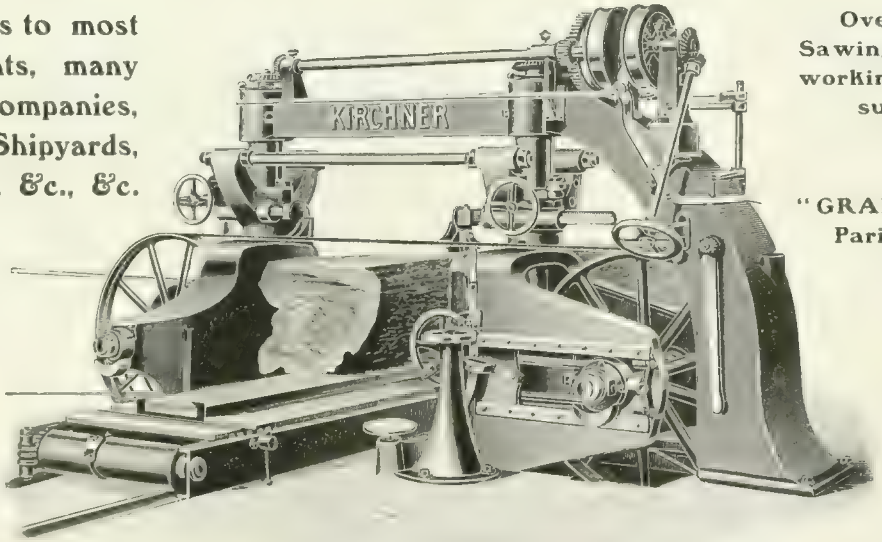

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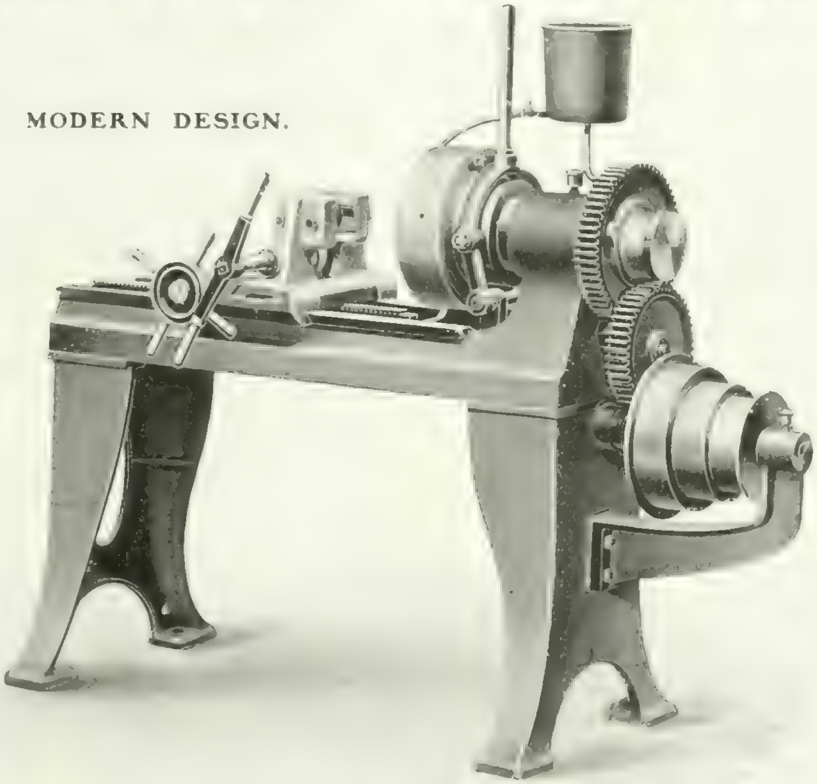

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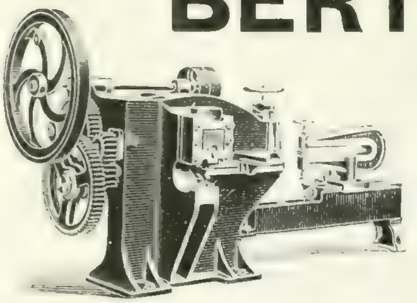

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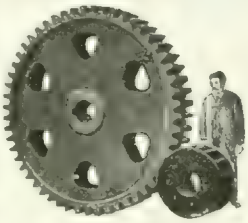

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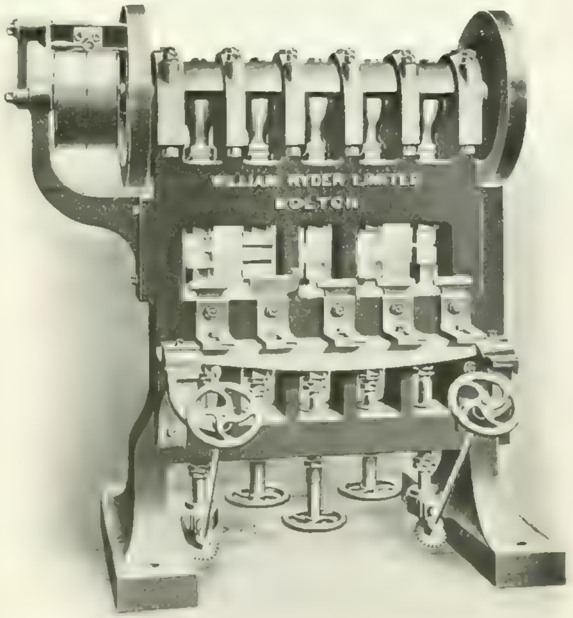

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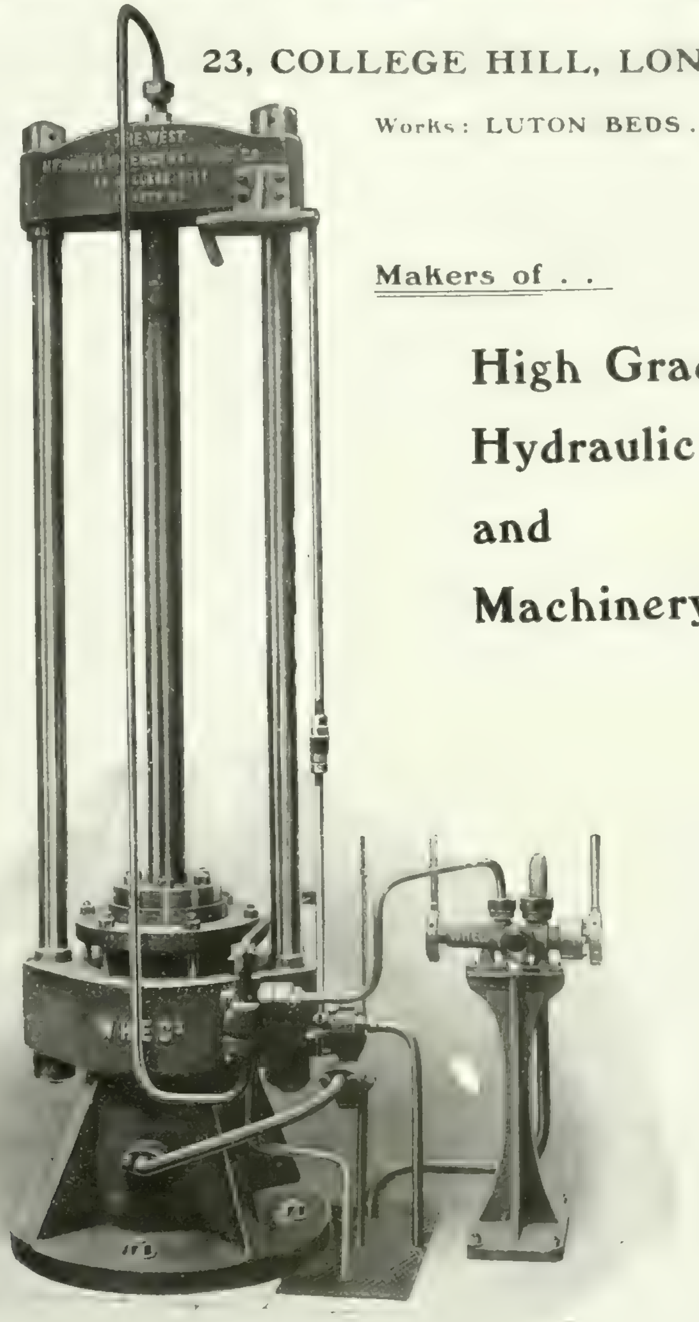

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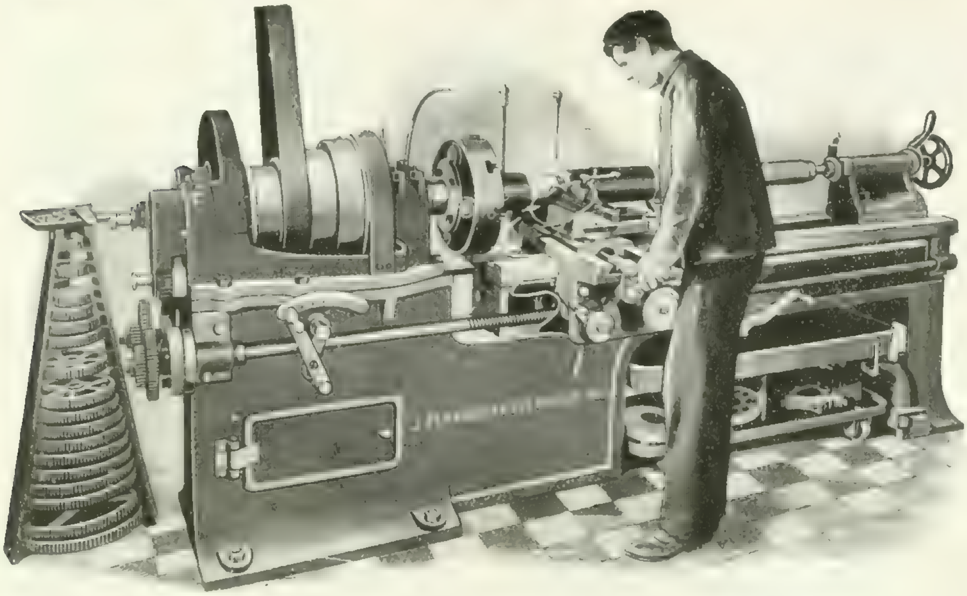

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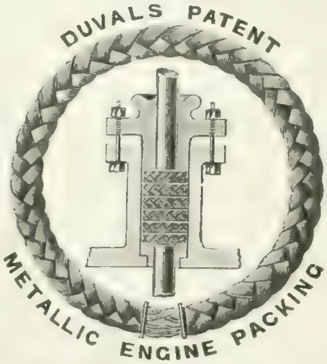

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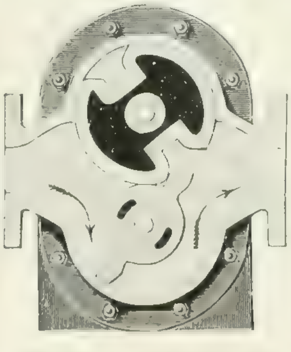

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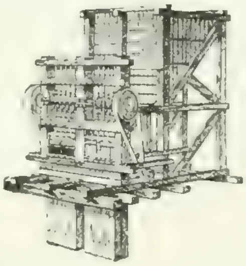

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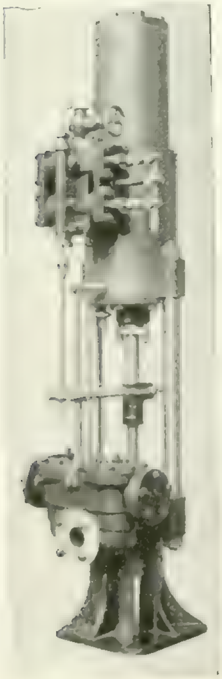

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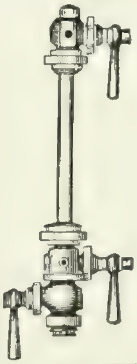

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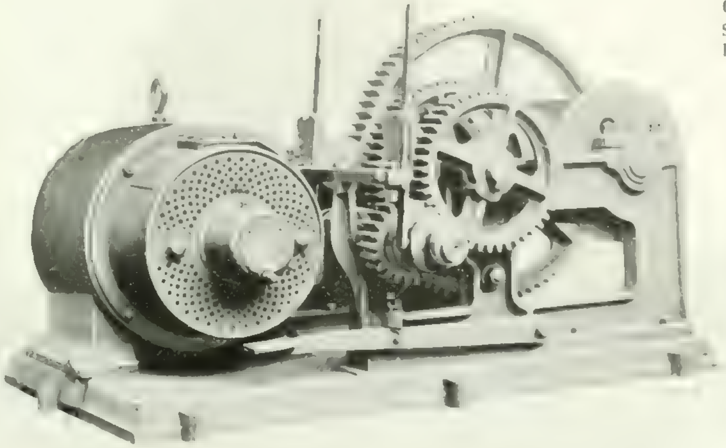

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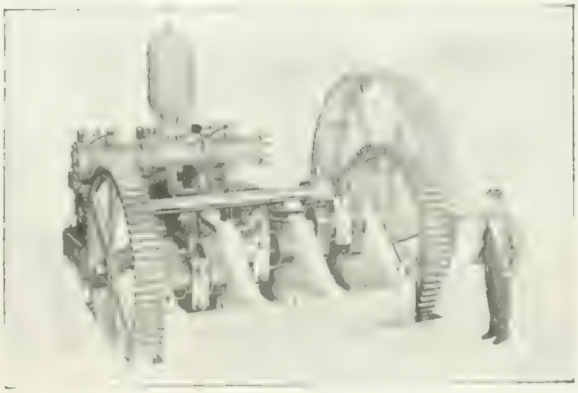

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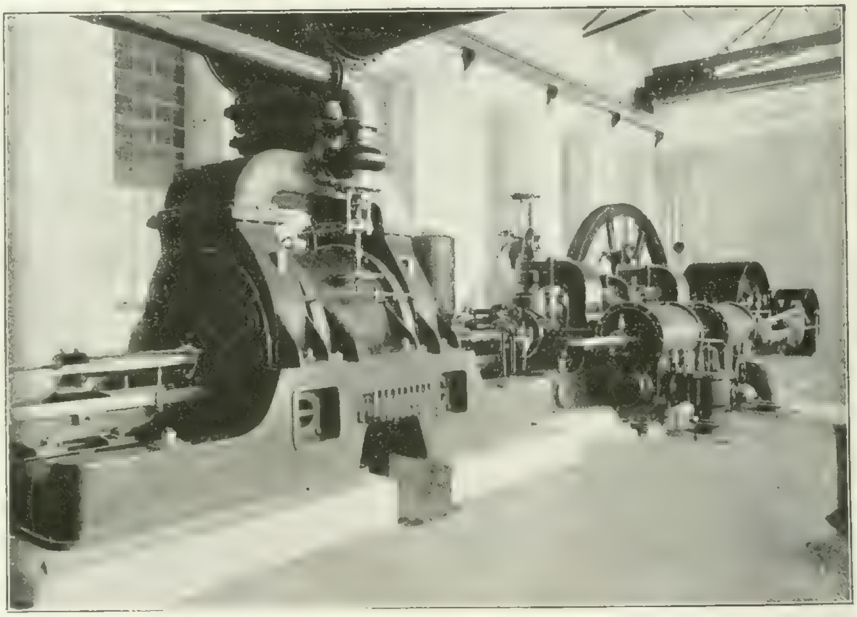

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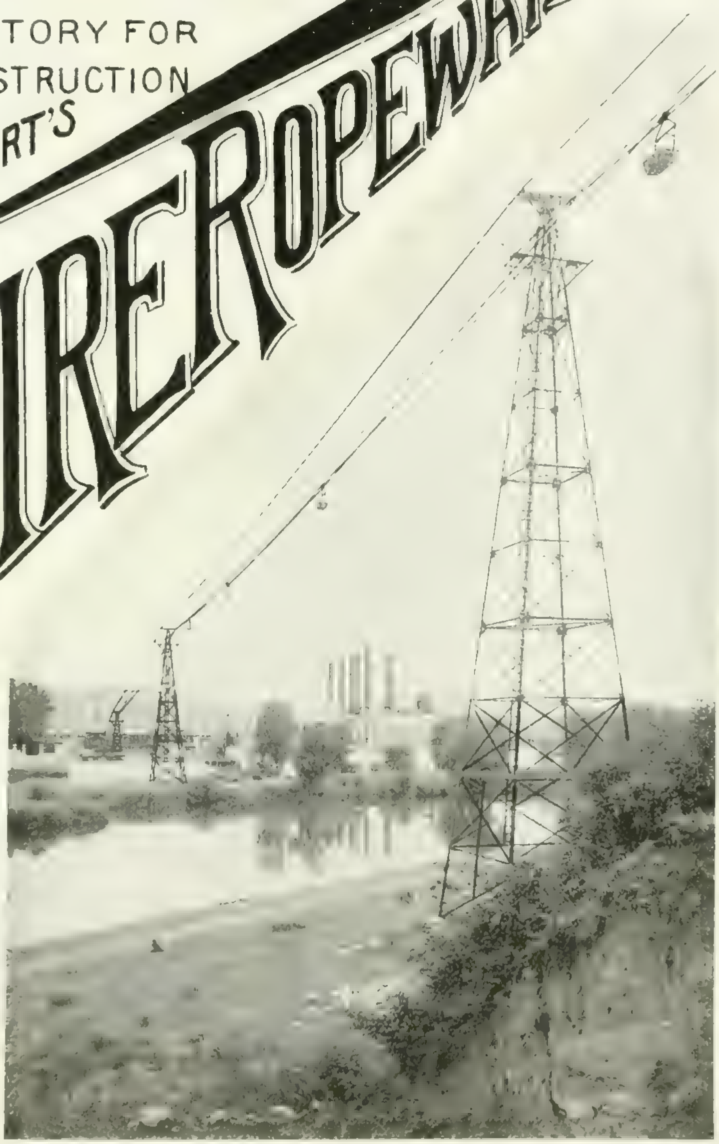

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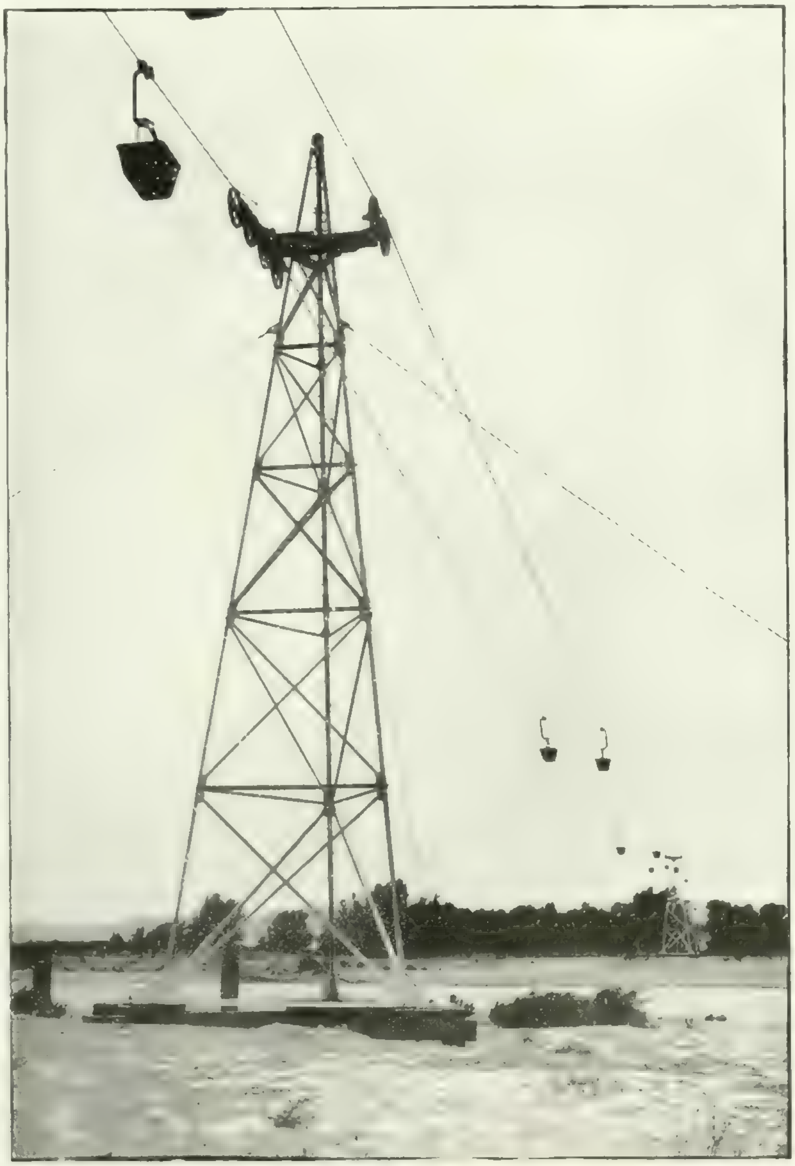

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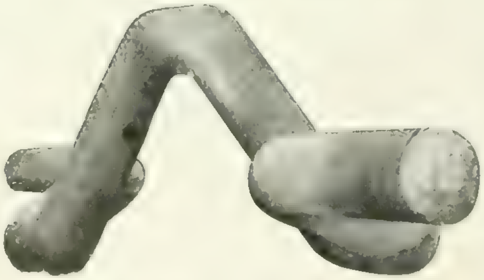

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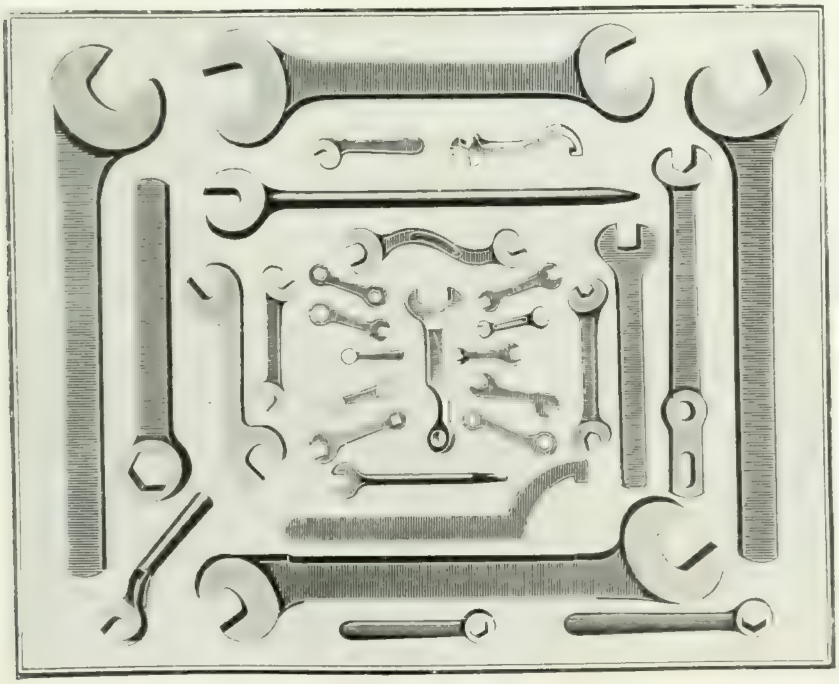

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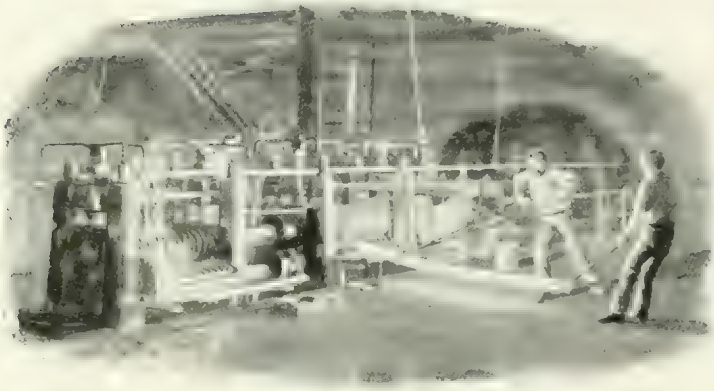

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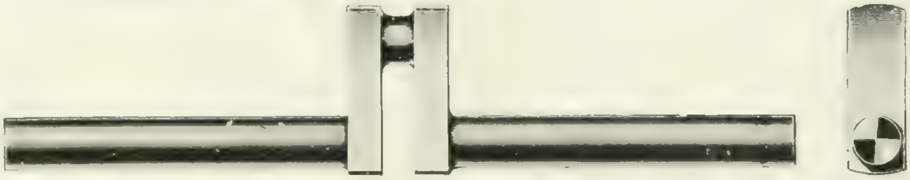

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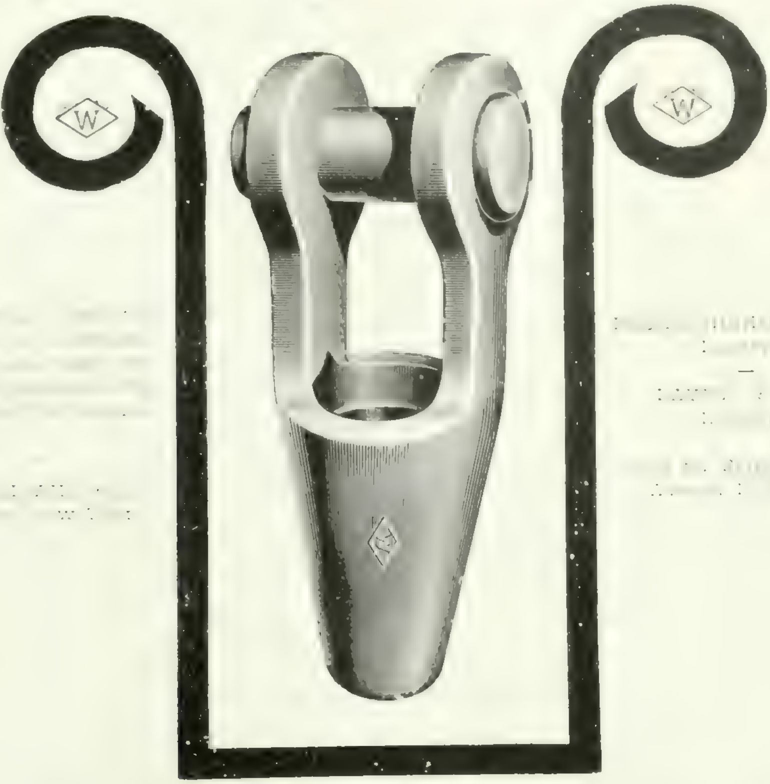

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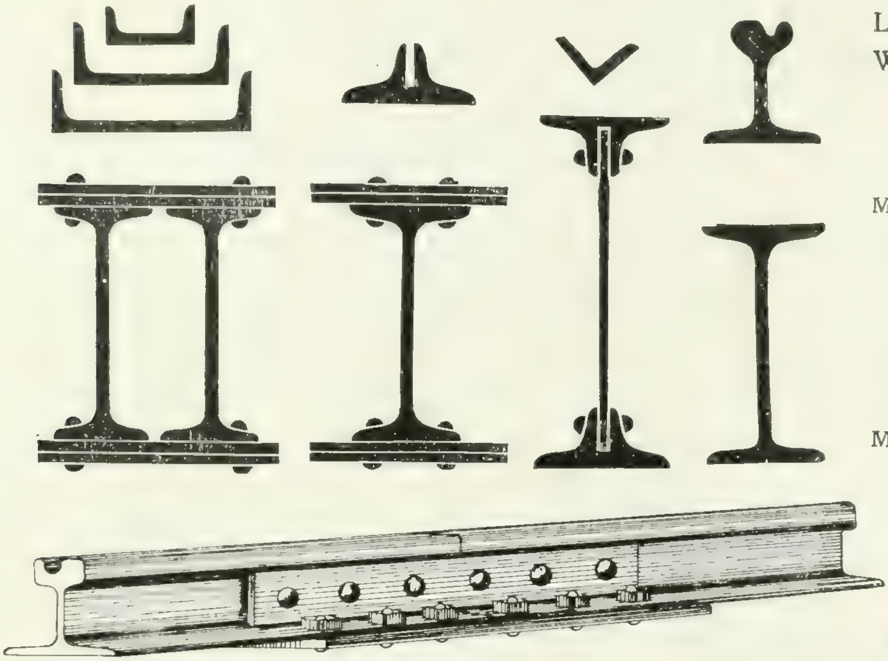

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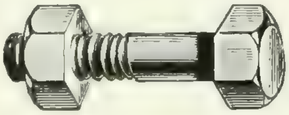

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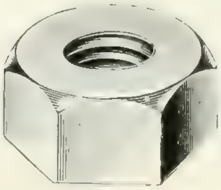

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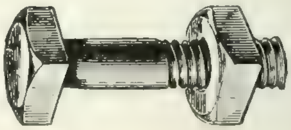

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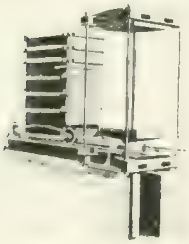

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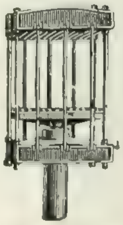

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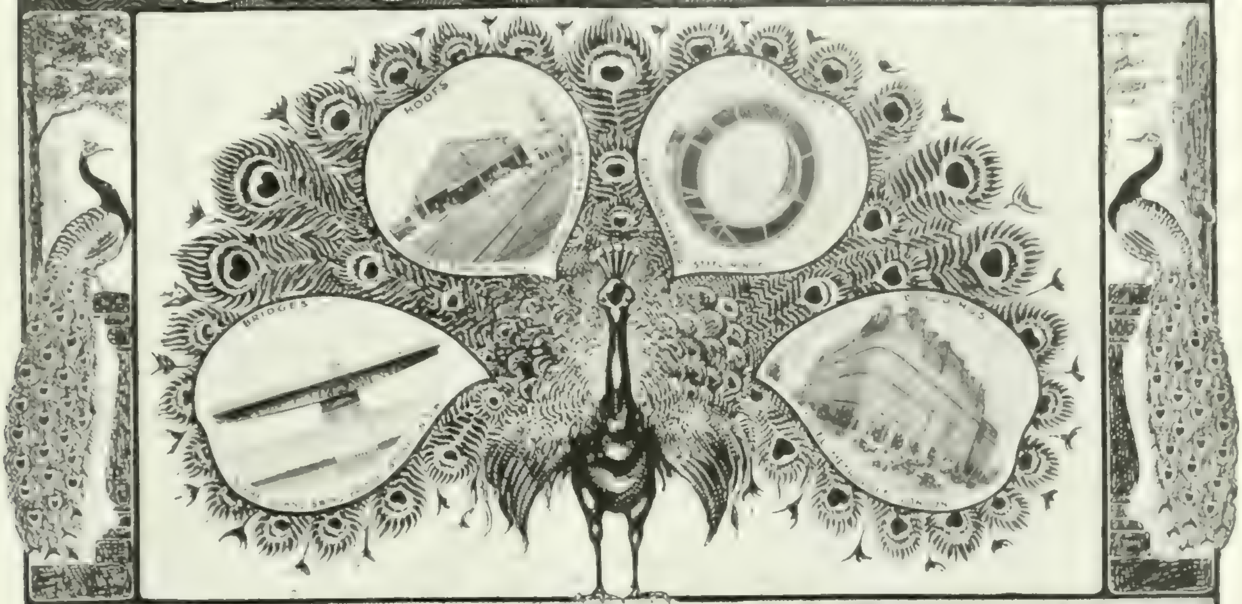

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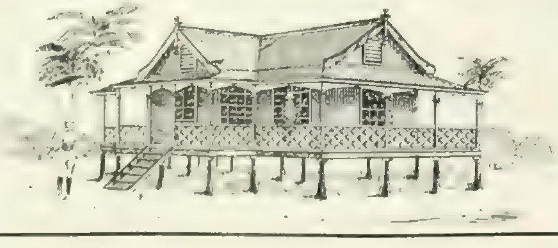

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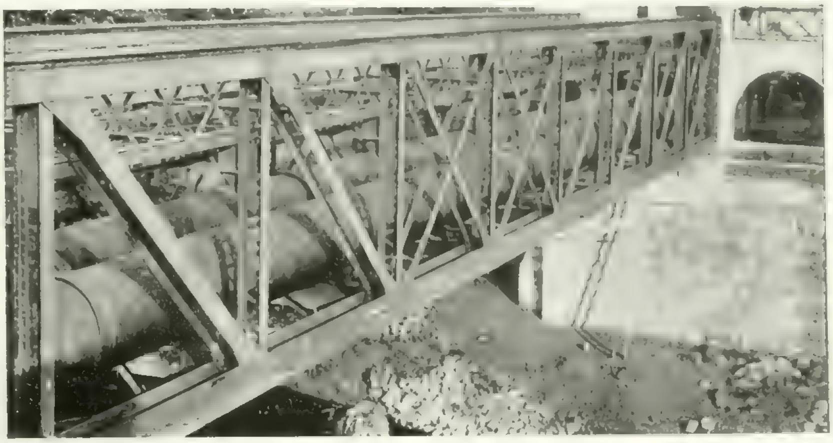

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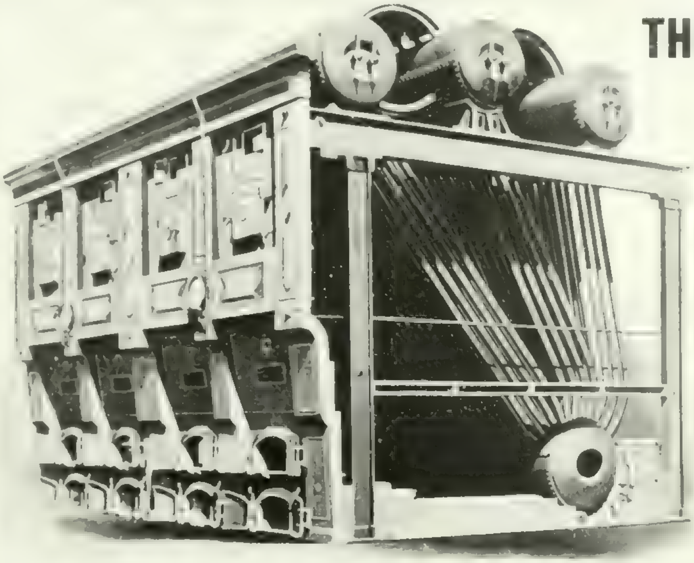

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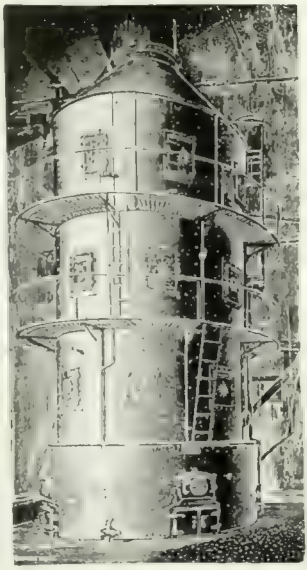

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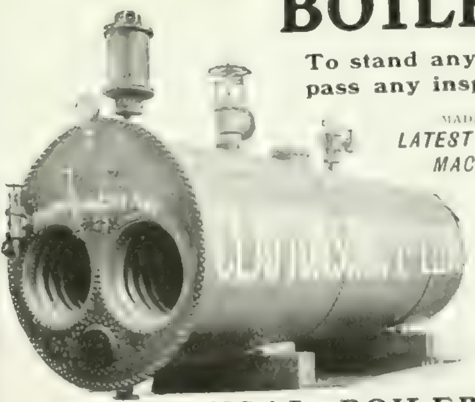

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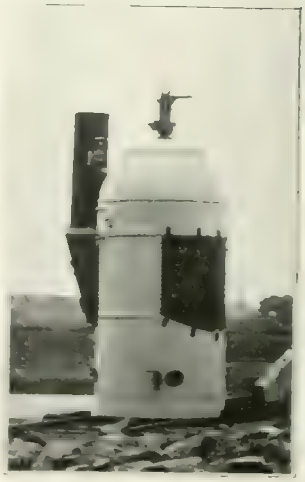

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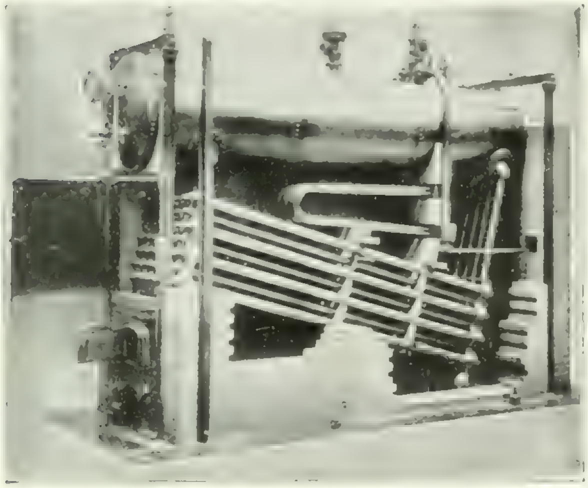

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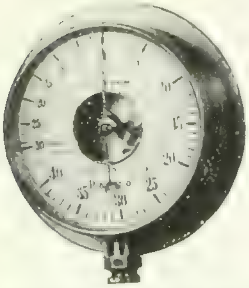

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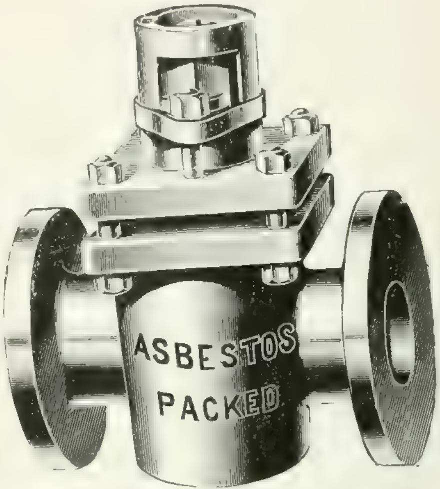

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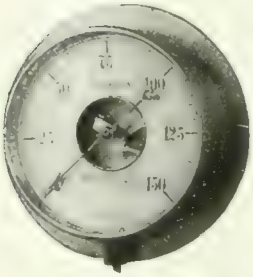

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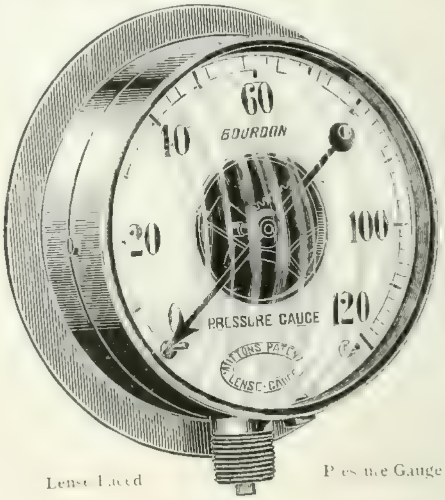

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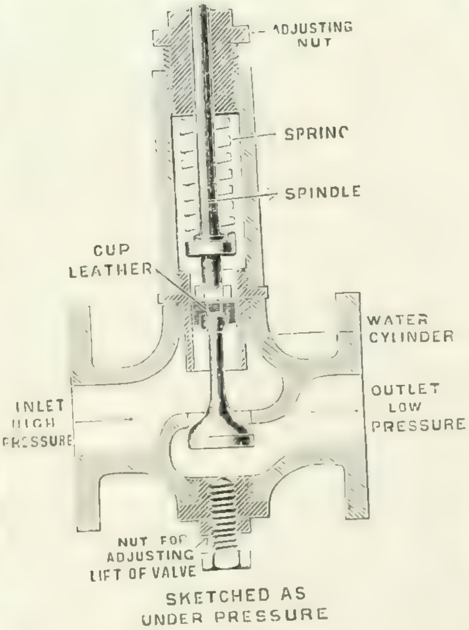

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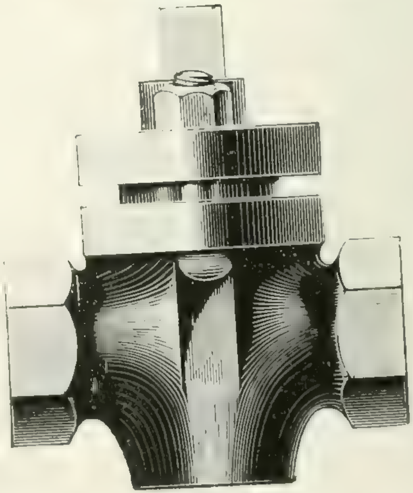

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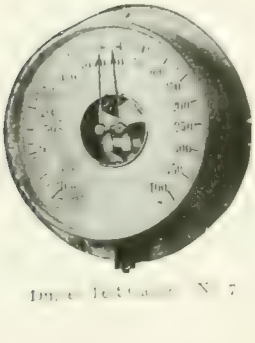

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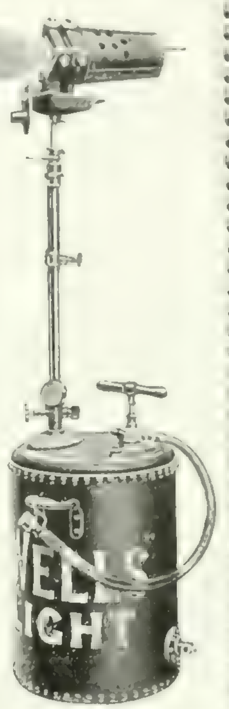

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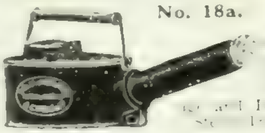

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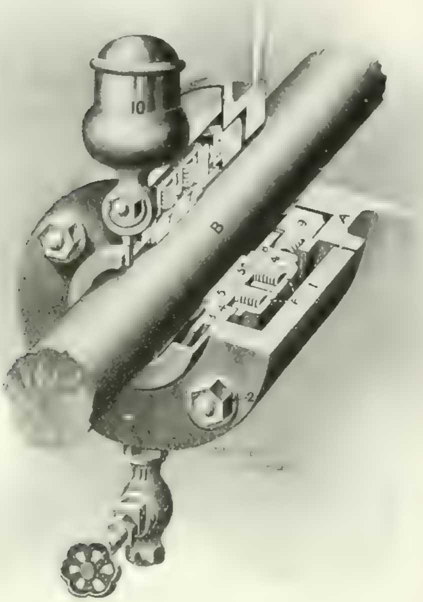

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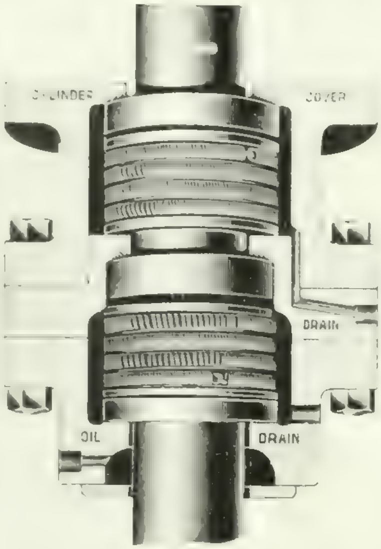

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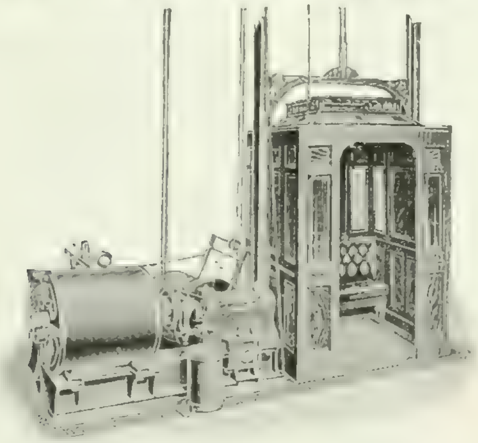

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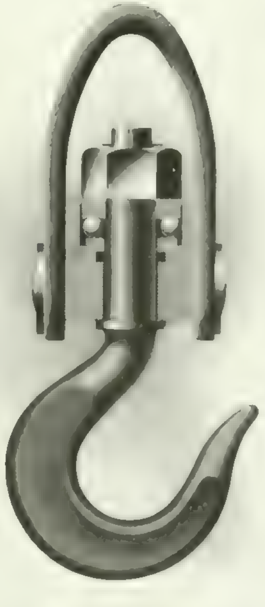

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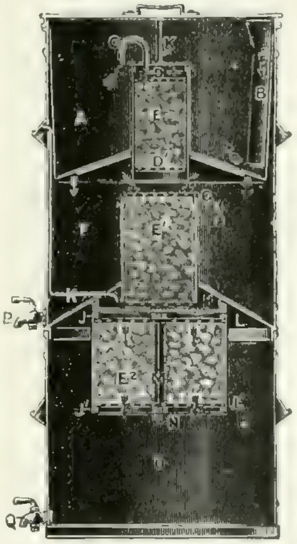

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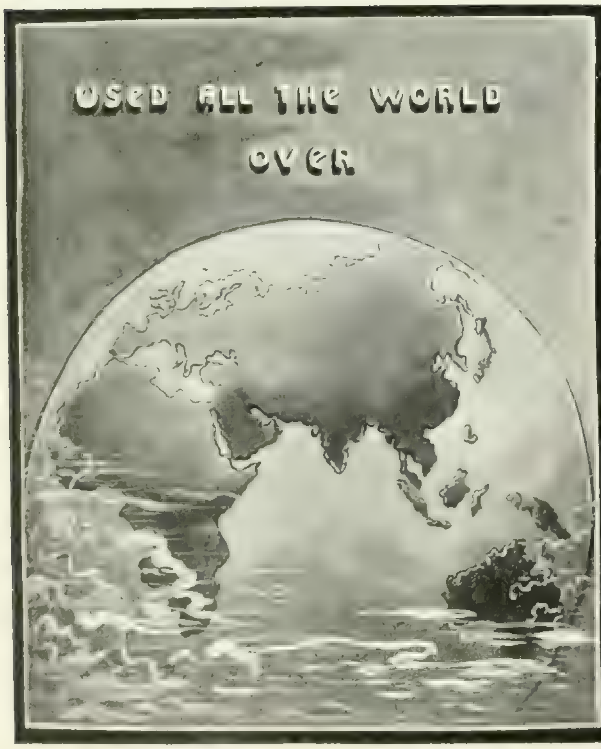
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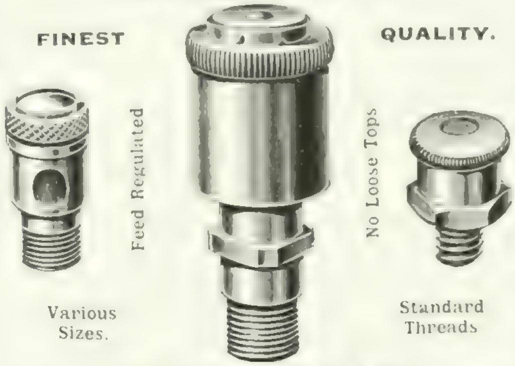

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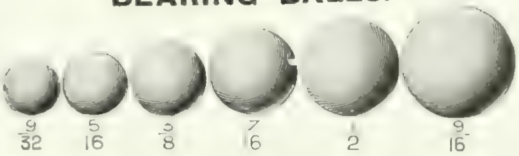

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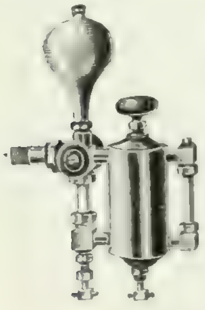

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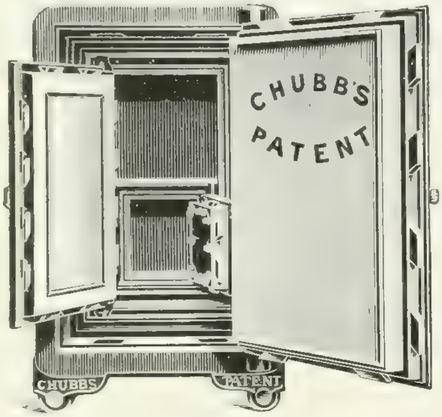

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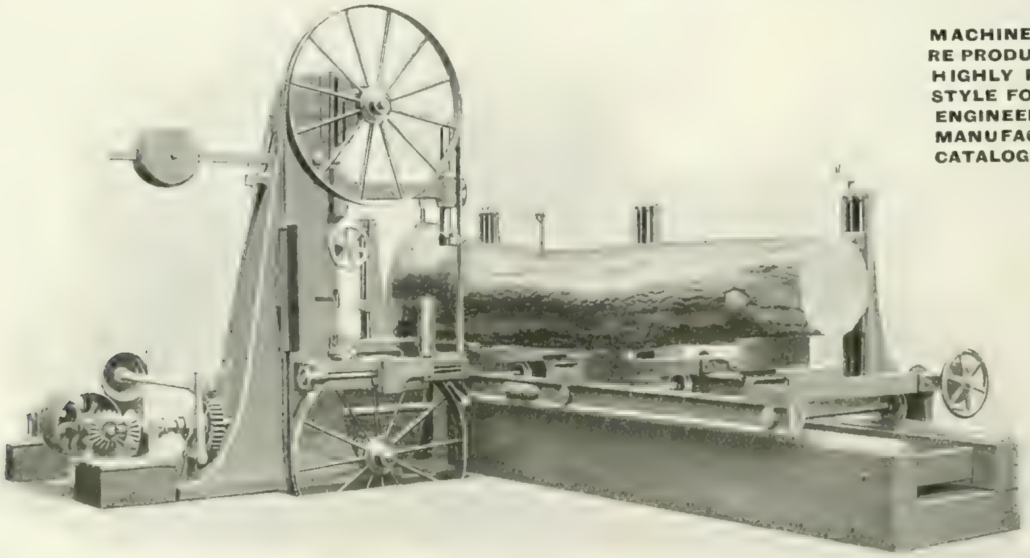

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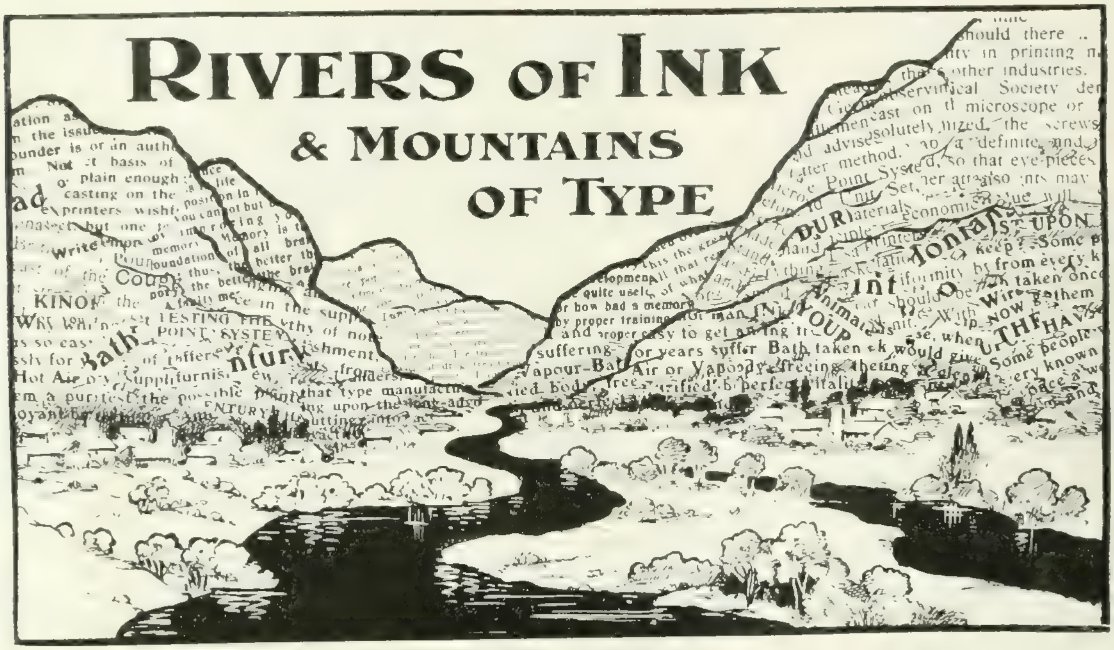

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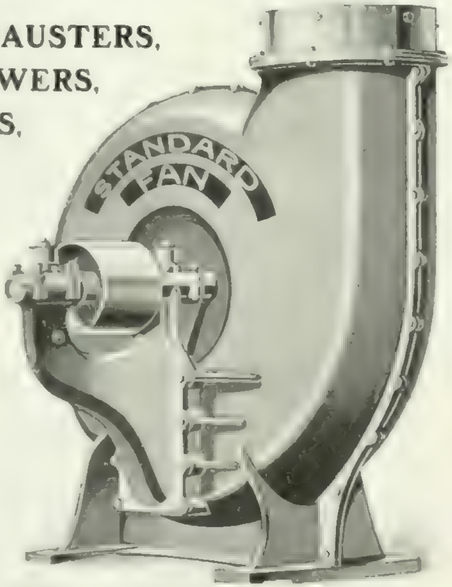

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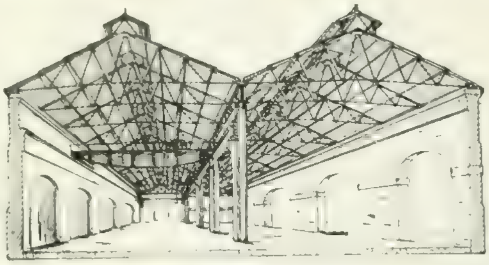

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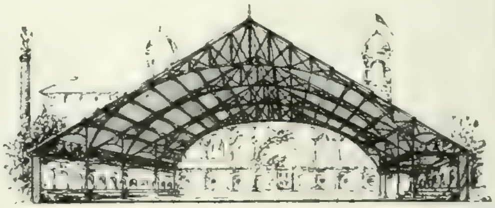

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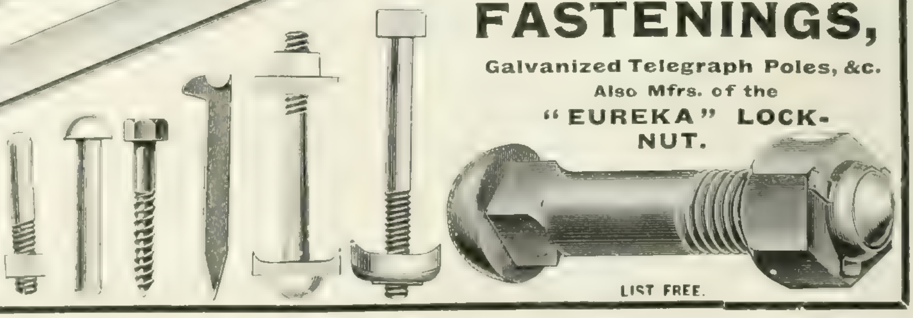


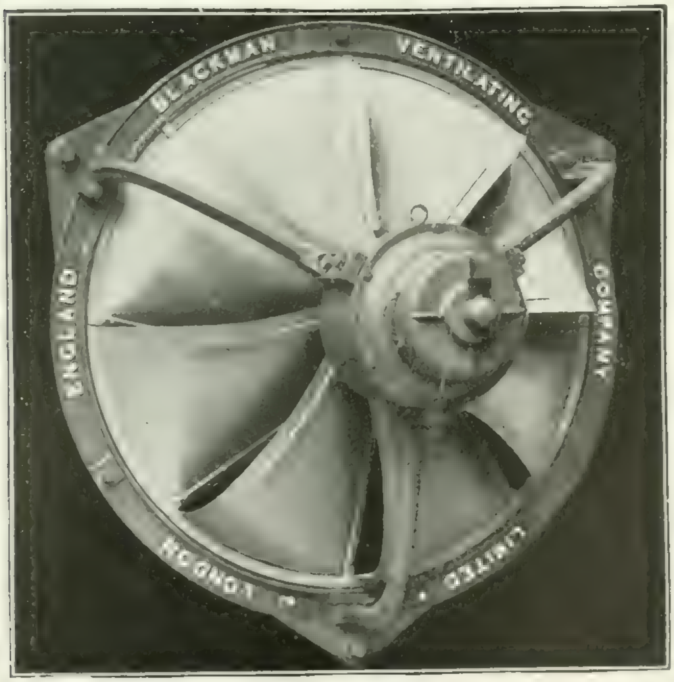
INDEX TO ADVERTISERS

PAGE
Adie, George & Co. 17
Allgemeine Elektricitäts-Gesellschaft 88
Anderson, D., & Son, Ltd. [illegible]
Armstrong, Stevens & Son 34
Ashton, Thomas A., Ltd.... 51
Asquith, W. 12
Auto Machinery Co., Ltd. [illegible]
Automatic Addressing Bureaux, Ltd. ... [illegible]
Avery, W. & T., Ltd. 3

Babcock and Wilcox, Ltd. 45
Bayliss, Jones & Bayliss, Ltd. [illegible]
Becker, R. & Co.... ... . [illegible]
Bertrams, Ltd. 22
Blake and Knowles' Steam Pump Works, Ltd. 75
Bleichert, Adolf, & Co. ... ... [illegible]
Blumann & Stern, Ltd. ... ... [illegible]
Booth, Joseph & Brothers, Ltd.... ... ... [illegible]
Bridge, David, & Co. ... [illegible]
Britannia Engine and Tool Factory [illegible]

PAGE
[illegible] [illegible]
Broadbent, Thos. & Sons, Ltd. [illegible]
Brown Bayley's Steel Works, Ltd. 33
Brown Hoisting Machinery Co. 72
Brush Electrical Engineering Co., Ltd. 65
[illegible] 55
Buffoline Noiseless Gear Co. ... ... [illegible]
Bullivant & Co., Ltd. 29
Burton, C. W., Griffiths & Co. 16

Chester, Edw. & Co., Ltd. .. 26
Chubb & Son's Lock and Safe Co., Ltd. .. 52
Churchill, Charles, & Co., Ltd. 11
Churton, T. Harding 89
Clarke's Crank & Forge Co., Ltd. ... 36
Clayton, Son & Co., Ltd.... 43
Cleveland Bridge and Engineering Co. [illegible]
Cochran & Co., Annan ... 44
Combination Metallic Packing Co., Ltd. ... 48
Consett Iron Co., Ltd. 32



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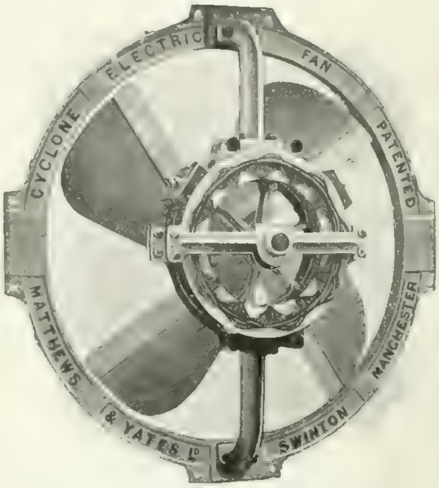

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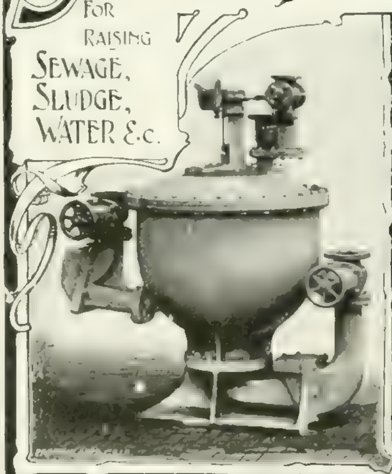

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Index to Advertisers—(Contd.)

PAGE

Crompton & Co., Ltd. 74
[illegible] ... [illegible]
Cunliffe & Croom, Ltd. ... ... [illegible]

Davidson & Co., Ltd. ... ... [illegible]
Davies & Sons, Richard ... ... [illegible]
[illegible] ... [illegible]
Deighton's Patent Flue & Tube Co., Ltd. ... 72
Denison, S., & Son 92
Dobbie-McInnes, Ltd. ... ... [illegible]
Drum Engineering Co. ... [illegible]

[illegible] ... [illegible]

Farnley Iron Co., Ltd. ... ... [illegible]
[illegible] ... [illegible]
Fleming, Birkby & Goodall, Ltd. [illegible]
Fowler, John, & Co. (Leeds), Ltd. [illegible]
Fraser & Chalmers, Ltd.... ... ... [illegible]
Frictionless Engine Packing Co., Ltd. [illegible]

Galloways, Ltd. ... ... [illegible]
Gilkes, G., & Co., Ltd. 80
Glover, M., & Co. ... 71
Graham, Morton & Co. 70
Green, E., & Son, Ltd. ... ... Inside Back Cover
Greenwood & Batley, Ltd. [illegible]
Griffin, Charles, & Co., Ltd. ... 59
[illegible] ... [illegible]

Hadfield's Steel Foundry Co., Ltd. . 65
Halden, J., & Co. [illegible]
[illegible] ... [illegible]
Handyside, Andrew, & Co., Ltd. [illegible]
Hardy Patent Pick Co. Ltd. [illegible]
Hathorn, Davey, & Co., Ltd [illegible]
Hindley, E. S., and Sons... [illegible]
Horsfall Destructor Co [illegible]
Howes, S. ... [illegible]
Hudswell, Clarke & Co., Ltd . 64
Hughes & Lancaster [illegible]
Hughes, G. H. ... [illegible]
Humbolt Engineering Works Co. 25
Hunslet Engine Co. ... ... [illegible]
[illegible] .. [illegible]

International Electrical Engineering Co. [illegible]
International Time Recording Co. [illegible]

Kaye, Joseph, & Sons, Ltd. ... ... [illegible]
Keep, Juxon & Co. [illegible]
Keith, J., & Blackman Co., Ltd. 57
Kiessling's Machine Co. ... ...
Kirchner & Co. ... ... [illegible]
Krupp, Fried. [illegible]

Lancaster & Tonge, Ltd. ... ... [illegible]
Leeds Forge Co., Ltd. 71
Library Bureau, Ltd. 95
Library Supply Co. ... ... [illegible]
Lobnitz & Co., Ltd. [illegible]

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Index to Advertisers--(Contd.)

PAGE
Luke and Spencer, Ltd. 20
Lyle Co., Ltd. 97

Mabie, Todd & Bard 91
McLaren, J. & H. ... ... Back Cover
Magnolia Anti-Friction Metal Co., Ltd. 63
Main, A. & J., & Co., Ltd. 56
Mason, W. F., Ltd. 79
Matthews & Yates, Ltd. 58
Meldrum Bros., Ltd. 78
Melling, J. F. 26
Mellowes & Co. 60
Met. Amalgamated Ry. Carriage & Wagon Co., Ld. 62
Mills, Edwin, & Son 38
Mosses & Mitchell 51

Nicholson Tool Co. 15

Parker Foundry Co. 33
Parkinson, J., & Son 24
Partridge & Cooper, Ltd. 98
Periam, H. W. Ltd. 45
Phœnix Dynamo Mfg. Co. 89
Phosphor Bronze Co., Ltd. 53
Piggott, Thos., & Co., Ltd. 41
Pochin, E. Arnold 80
Polishers' Supply Co. 100
Portable Building Co., Ltd. 42
Pratt & Whitney Co. 14

PAGE
Pressed Steel Car Co. 68
Pulsometer Engineering Co., Ltd. 61

Reliance Lubricating Oil Co. 18
Remington Typewriter Co. ... 90
Renshaw, W. R., & Co., Ltd. 68
Rice & Co. (Leeds), Ltd... 18
Riter-Conley Mfg. Co. ... ... —
Robey & Co., Ltd. 5
Rockwell-Wabash Co., Ltd. 96
Ropeways Syndicate, Ltd. 31
Rose, Downs & Thompson, Ltd. 72
Rowland, B. R., & Co. 43
Royles, Ltd. 44
Ryder, William, Ltd. 22

St. Helen's Cable Co., Ltd. 86
Schischkar & Co., Ltd. 20
Scotch & Irish Oxygen Co., Ltd. 85
Scott & Mountain, Ltd. 27
Scott, Walter, Ltd. 38
Selig, Sonnenthal & Co. 13
Shannon, Ltd. 94
Smith's Stamping Works, Ltd. ... ... —
Smith, Thomas & Sons, of Saltley, Ltd. 35
South Eastern & Chatham Ry. ... . -
Southwood, Smith & Co., Ltd. 54
Spon, E. & F. N. 6

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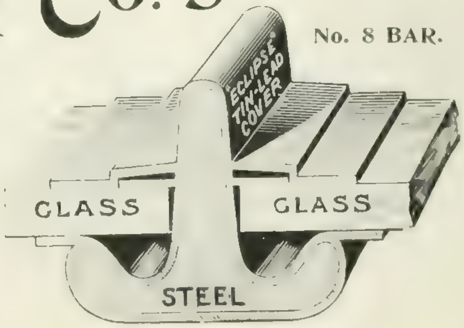

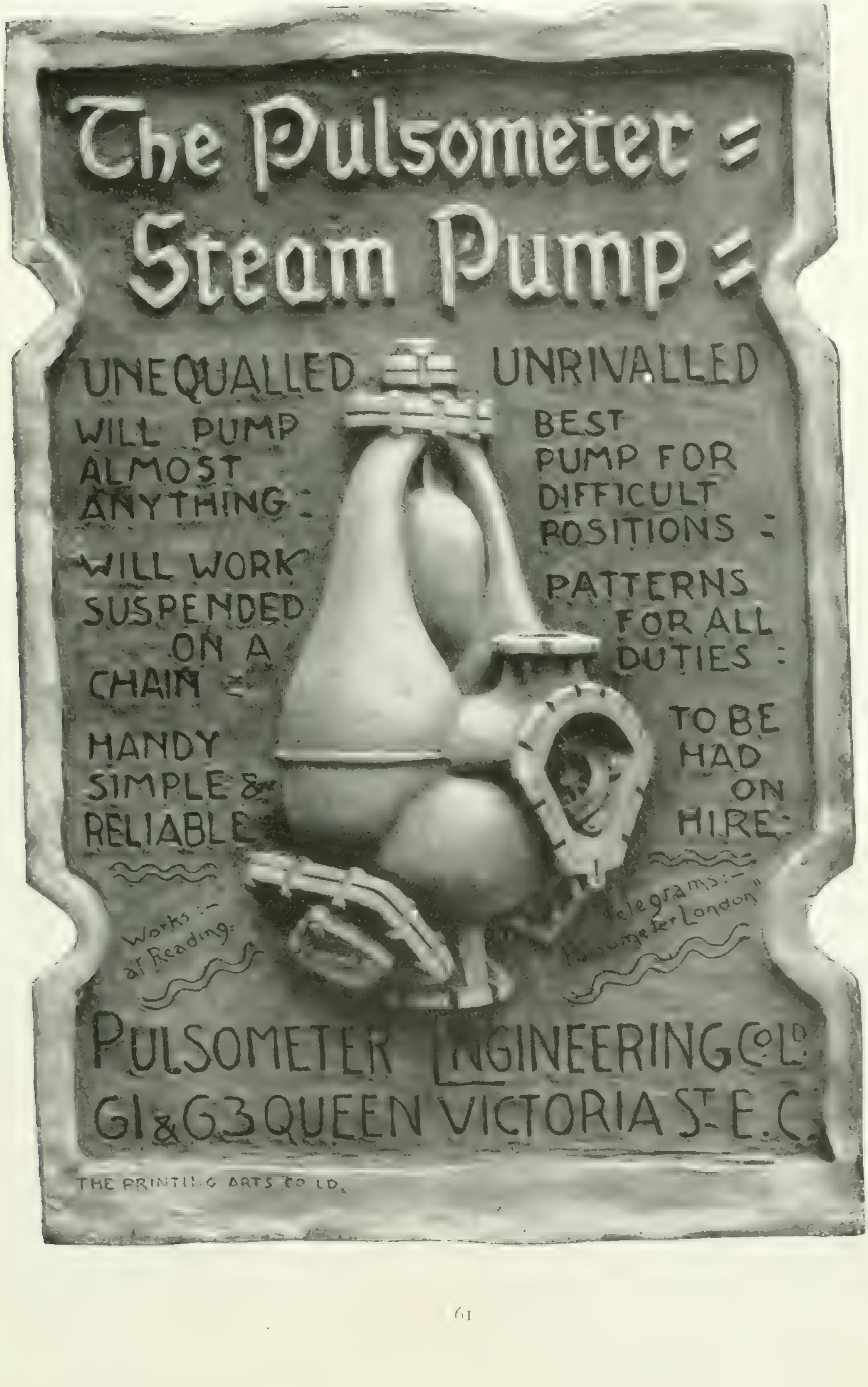

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Index to Advertisers (Contd.)

PAGE

Stamm, W. .. 33
Standard Engineering Co., Ltd. .. 55
Stirling Co. of U.S.A. 43
Süddeutsche Kabelwerke, A.-G. 85
Summerscales, W., & Sons, Ltd. 73
Swain, John & Son, Ltd 52

Tangyes Ltd. 73
Taylor & Challen, Ltd. 18
Teale & Co. 51
Thom, John H. 53
Thornycroft Steam Wagon Co., Ltd. .. 71
Treasure, J. B., & Co. 29
Triumph Stoker, Ltd. 61
Tubes, Ltd. 42
Turner, Atherton & Co. 62

United Kingdom Self-Adjusting Anti-Friction Metallic Packing Syndicate, Ltd. 62

PAGE

United States Metallic Packing Co., Ltd. 48

Vacuum Oil Co., Ltd. 50
Von der Heyde, J. Bennett 24

Ward, H. W., & Co . . 24
Ward, T. W. 17
Waygood & Otis, Ltd. 49
Weldless Steel Tube Co., Ltd. 41
Wells, A. C., & Co. 47
West Hydraulic Engineering Co. 23
Westinghouse Co., The British ... Inside Front Cover
Wheeler Condenser and Engineering Co. 76
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Willcox, W. H., & Co., Ltd. 51
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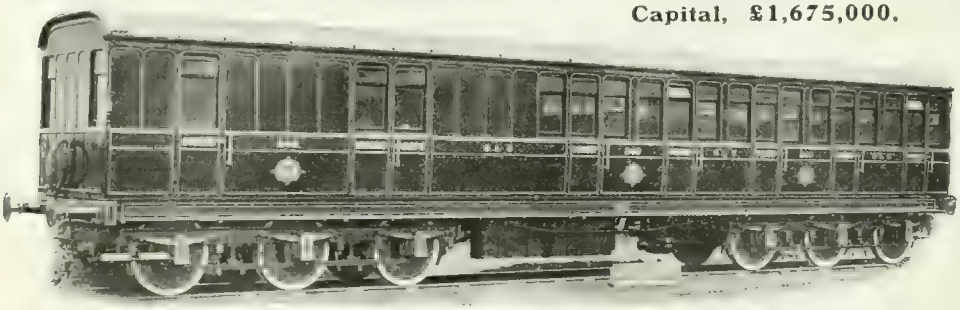

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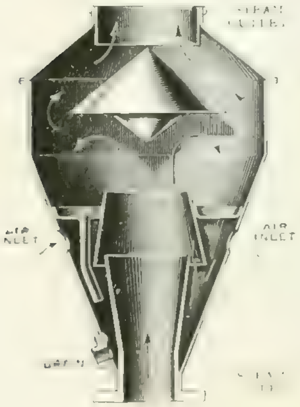

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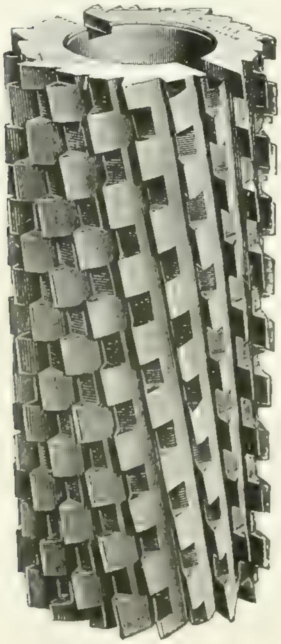

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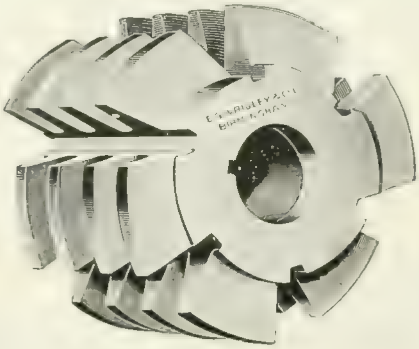

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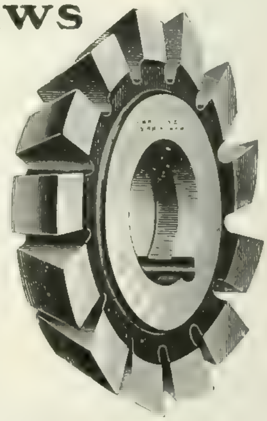

RIGHT HAND CUTTER
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VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO NORTHERN ITALY.

(See the illustrated article in this issue.)

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron and Steel, Mining and Allied Industries.

VOL. II. LONDON, MAY, 1903. No. 5.

THE FRENCH CRUISER "CHATEAURENAULT."

Length, [illegible] ft. Displacement, 8,018 tons. I.H.P., 24,800. Speed on trials, 24½ knots. Thickest Armour Protection, [illegible] Deck. Heaviest Guns, 6.4 in. quick-firers.

THE RELATIVE IMPORTANCE OF OFFENSIVE AND DEFENSIVE QUALITIES IN MEN-OF-WAR.

BY

SIR WILLIAM LAIRD CLOWES.

In view of the progressive naval policy which is now before the country and the prospect of a large expenditure on further additions to the British Navy, it seemed an opportune time to invite Sir William Laird Clowes—one of the leading naval experts of the day—to criticise the present tendencies of battleship construction, and we trust that the following article will stimulate the interest in naval matters which we have reason to believe is felt by the majority of our readers. For the excellent series of views showing the various stages in the construction of a modern battleship, we are indebted to the Thames Iron Works, Shipbuilding and Engineering Company, Limited.

Other articles on kindred subjects which have appeared in PAGE'S MAGAZINE, are: "The Gun *versus* the Armour Plate" (October, 1902), and "The Distribution of Guns in Battleships" (January, 1903).

IN the old days, when a war broke out between England and France, the operations of British seamen during the earlier part of the campaign were usually handicapped by the inferiority of the vessels in which they were sent to sea. British warships of those times were almost invariably worse sailers than French warships of corresponding size, class, and armament. No doubt the British vessels possessed, or were alleged to possess, some compensating advantages; but those advantages, no matter what they may have been, were soon realised to be of subsidiary importance. The result was that after a few years of hostilities our best ships were either captures from France, or craft built after French models. This sort of thing happened during every long French war between 1688 and 1815; yet, in spite of what occurred with such unfailing regularity, we generally reverted, after a peace, to our old methods of construction, and built more indifferent sailers, until a fresh war reminded us that speed was still a factor of prime importance, and that we had forgotten a lesson which we ought to have learnt once and for ever.

With regard to another important factor in naval warfare, we underwent a similar unpleasant awakening in the years following 1811, when we fell out with our American cousins. They had a navy which was ridiculous numerically. It was not more than one-fifteenth or one-twentieth of the size of the British Navy, which ought to have annihilated it, or swept it from the seas in six months. It is no exaggeration to say that, before the outbreak of the war, British naval officers, possibly with one or two exceptions, and certainly the whole of the British press, considered that for the United States single-handed to try conclusions with Great Britain at sea would be the height of impertinent folly; and the majority of thinking Americans, I am sure, believed that their chances were utterly hopeless. But among the early leaders of the young nation across the Atlantic were some ingenious and far-sighted men. They could not, they knew, create a big navy in those days, but they determined that although they could not have many ships they would have better ones, class for class, than any other Power.

They decided that the factor in which it would be most advantageous for their ships to excel was the factor of gun-power. Accordingly, they built and sent to sea frigates which were more heavily armed than the corresponding frigates of Great Britain; and, moreover, they made a great point of training their officers and men to a high state of efficiency in the practice of gunnery. At the same time, they saw to it that their ships should be good sailers. The result of all this was that, in spite of its immense numerical superiority, the British Navy lost frigate after frigate when our vessels of that rating were pitted against American vessels of the heavily armed type. Ere we were able to set matters right we had been obliged formally to forbid our more lightly gunned frigates to engage the crack American craft, and had even found it necessary to direct our captains to flee from the enemy. In the meantime we cut down ships of the line, and sent them to sea rated as frigates, in hopes of being able with them to stem the tide of ignominious defeat.

QUALITIES OF THE IDEAL FIGHTING SHIP.

In the cases to which I have called attention, speed and gun-power were valuable, because they were offensive factors for the absence or deficiency of which the presence of no other material factors could fully compensate. What they were then they still are—the prime essentials in a ship which is designed for the work of fighting. They are the leading and the indispensable offensive qualities.

I do not, of course, assert that they are the only offensive qualities which it is desirable to embody in the modern warship. Coal-carrying capacity is another desirable offensive quality. Ammunition-carrying capacity is yet another. Ability to use her guns under all conditions of weather is also a valuable offensive quality. So is sea-worthiness. So is security as a floating platform, after that platform has been damaged locally by shot, shell, or torpedo. So is habitability; for without moderately dry and comfortable quarters a crew cannot be kept in health and strength. Even armour itself, though mainly a defensive factor, is to some slight extent an offensive one as well. These are factors, all of which would be found in

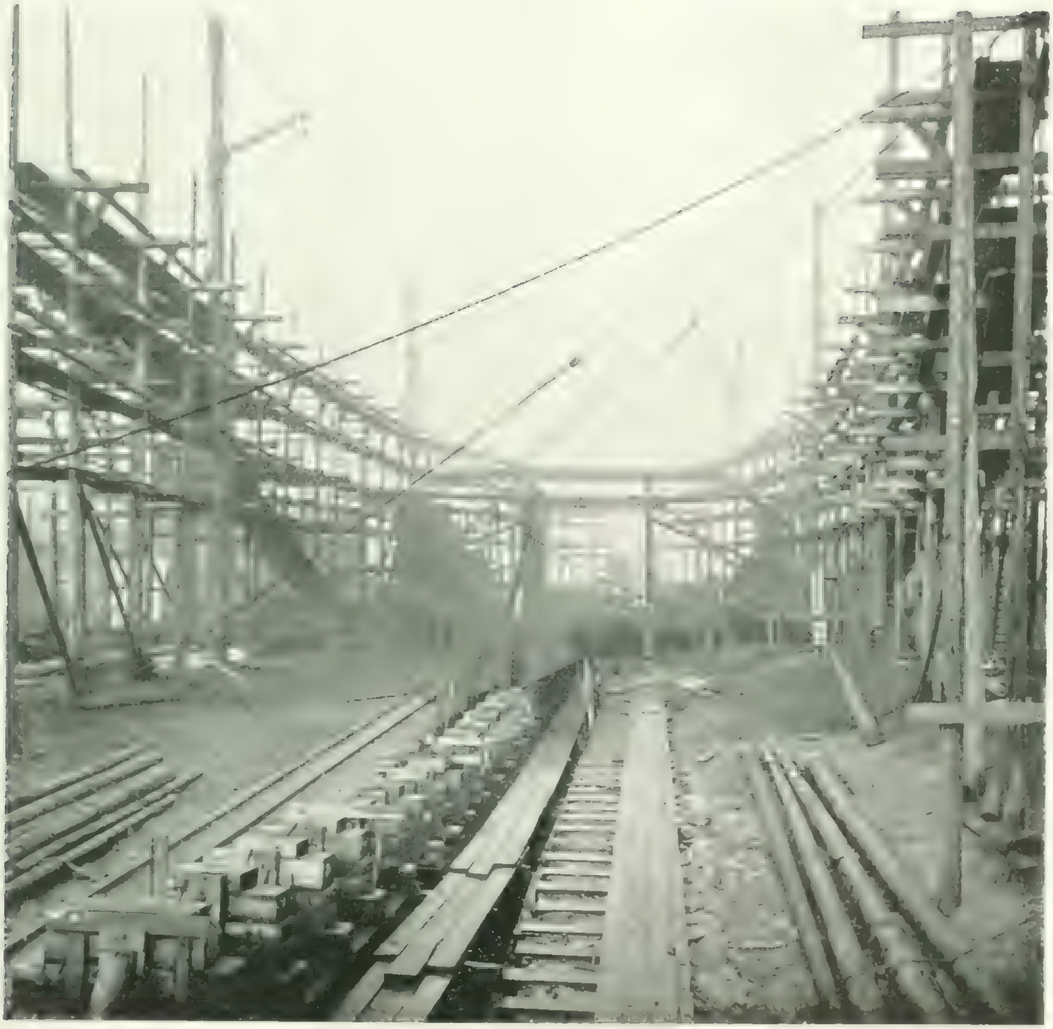

FIG. 1. THE BUILDING OF A BATTLESHIP.

This photograph is a good illustration of the staging arrangements which surround the ship, so that the workmen may get at the sides of the vessel. The [illegible] of the great battleship [illegible] in the immediate foreground.

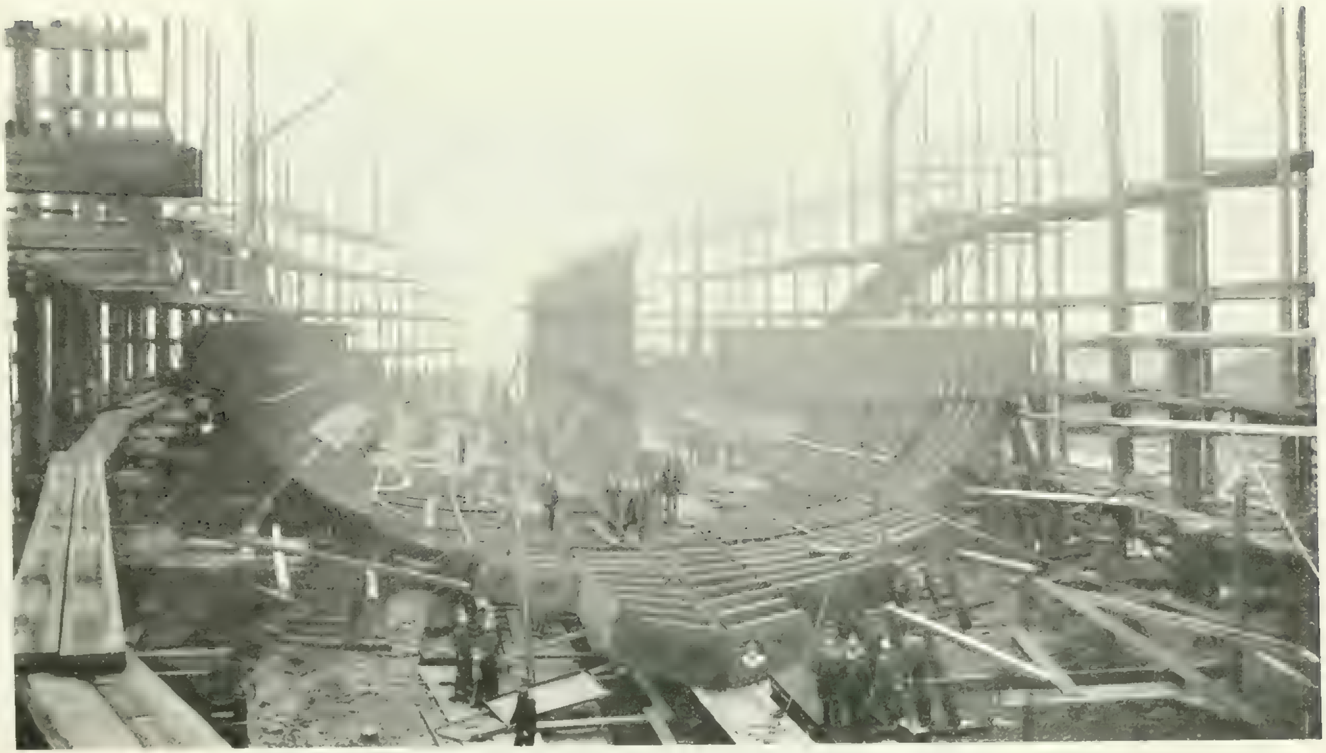

FIG. 2. THE DOUBLE BOTTOM FRAMES PARTLY FINISHED, AND MIDDLE LINE BULKHEAD UP.

perfection in the ideal fighting ship. But we have to admit that the ideal fighting ship is unattainable, and must ever remain so. Considerations of expense, dimensions, draught of water, and decentralisation step in; and we have to content ourselves with a compromise. When we are obliged, however, to sacrifice part of some factor which would find full development in the ideal fighting ship, do we always select a factor which is one of the least important? When we are driven to compromise, do we always retain as much as possible of the really essential?

I confess that I do not think that in our Navy these questions have hitherto secured the attention which they deserve.

A PERSONAL MATTER.

Before I proceed further, I want to clear the ground from certain obstructions of a personal nature, which hitherto have been allowed to prejudice and confuse any adequate discussion of the subject. In December last, within the compass of the very limited space which could be spared me in a single issue of the *Standard* newspaper, I ventured to point out, as a fact, that, as regards those qualities which I have characterised as the leading and indispensable offensive qualities in a fighting ship, many recent British vessels are inferior to foreign vessels of corresponding types, sizes, and classes. I had little or no room wherein to argue, or to give reasons for the faith that was in me. I had to set out my facts in a couple of columns; and, in consequence, I could only set them out broadly and baldly. This brought down upon me Sir W. H. White, the late Chief Constructor, who, in the course of three long articles contributed in reply, not to the *Standard*, but to the *Times*, elected to assume that in some way or other I had made a covert attack on him.

I have the greatest admiration for Sir William White's brilliant abilities, and for the immense services which he has rendered to the country by practically re-creating its fleet; and, knowing as I do, that the Chief Constructor is in reality allowed to have only a small part in the formation of the decision which dictates the nature of the compromise to be effected in the designing of a British warship. I am well aware that the broad principles governing the types, gunning, speed, and armouring of recent fighting craft for the Royal Navy represent the conclusions of the Board of Admiralty quite as much as, and perhaps more than, they represent the conclusions of the Chief Constructor.

Nevertheless, for the sake of convenience, I did refer to "Sir William White's ships," and to a building policy which has come to be associated with his name: for, of course, seeing that there were many changes at the Admiralty during Sir William's long and valuable tenure of the Chief Constructorship, there is no name so convenient as his for association with the general trend of building policy which was followed during the greater part of that period. Still, unless Sir William White desires it to be understood that he managed to override the views of successive Boards and successive Controllers, and persisted in under-gunning and under-engining British ships of war (which I take to be absurd), he has, I submit, no justification for regarding the article in the *Standard* as in any sense an attack on him. In that article, moreover, I did not attempt to burke the acknowledged fact that it is not generally open to a Chief Constructor to carry out all his own theories, no matter how sound they may be. On the contrary, I ventured to appeal for popular support for the new Chief Constructor, in case he should endeavour, while at the Admiralty, to carry out the same broad principles of warship designing as he has carried out, with, I think, conspicuous success at Elswick for many years past. There is thus no personal question at issue; and it was entirely beside the mark for Sir William White to assure his readers, as he did assure them, that, if only the Board had desired it, he could have mounted more, or heavier guns in the

Terrible, or given some other cruiser an extra knot of speed. Nobody doubts it.

The points under discussion are, indeed, not shipbuilding questions, but strategical and tactical ones. I trust that it will not again occur to Sir William White, or any one else, to drag the personal red-herring across the track, and so confuse the scent.

DISPOSAL OF ARMOUR.

Let me now examine in brief the various desirable qualities which would be found, all in great perfection, in the ideal man-of-war. I will begin with those which are mainly defensive; and of those the first is armour.

Armour, especially external armour, which is capable of causing all, except perhaps the very heaviest shells to burst outside the ship to which it is applied, is a most valuable defensive factor. Used very liberally, indeed, it may afford an extraordinary amount of protection not only to the man behind the gun, but also to the fabric of the vessel. But, in practice, it cannot be used very liberally. If it has great superficial area, it must be, at least in most places, relatively thin. If much of it be thick, the superficial area must be relatively small. It is most difficult, without overweighting an ironclad, to give her armour at once so thick

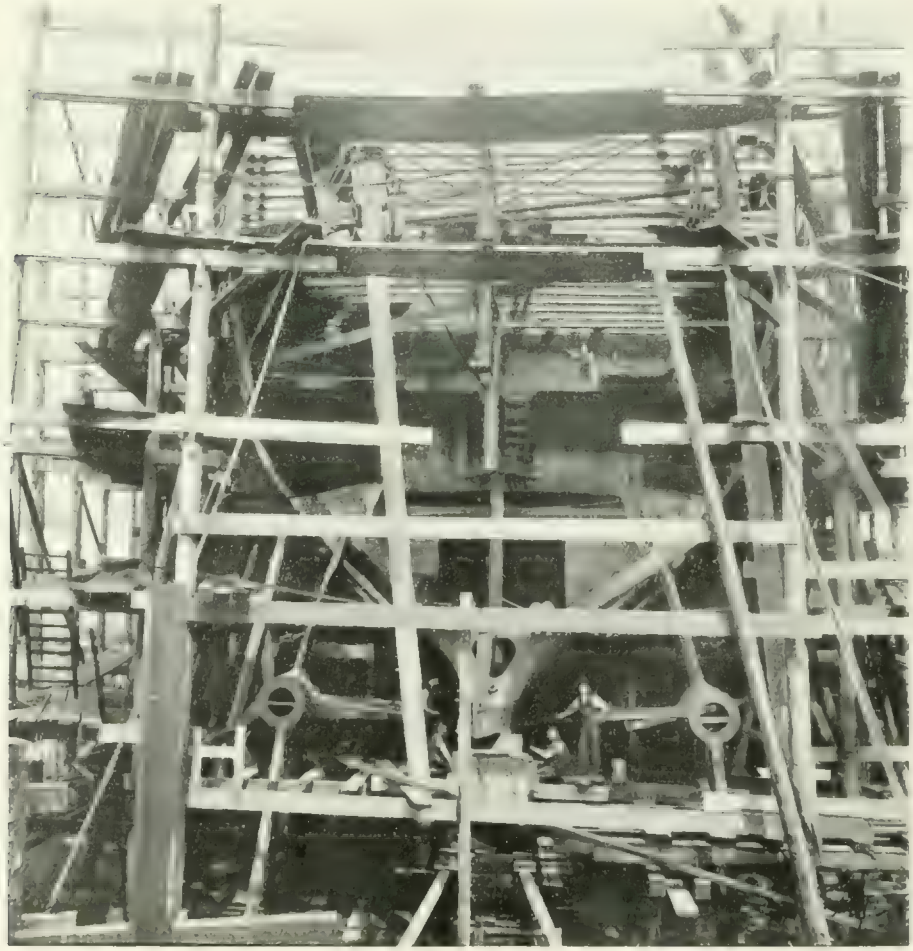

FIG. 3. ILLUSTRATES THE MODERN METHOD OF BUILDING THE STERN TUBES SOLIDLY INTO THE GENERAL STRUCTURE OF THE SHIP.

and so extensive as to render her everywhere invulnerable to comparatively light projectiles. If you concentrate and thicken the armour over particular parts, you leave other parts so vulnerable and extensive that any general piercing of them may imperil the safety of the vessel. As for heavy armour, which is not purely external, its presence is possibly even more dangerous than its absence would be. Heavily armoured barbettes, shot-hoists, and internal bulkheads may cause big shells, which otherwise might pass through without bursting, to burst within the hull, and so do a maximum of damage, if not to the fabric, at least to the crew. Armour, therefore, may have positive disadvantages as well as advantages. Its great weight requires that, if it be at all freely employed, corresponding reduction of other weights must be made. The other great weights of a ship are engines, guns, coal, and ammunition. They are all, in various degrees, offensive weights. In proportion as you sacrifice them, you sacrifice offensive power; and, surely, that is the last factor which ought to be sacrificed in a man-of-war.

Yet, it will be urged, we must put armour upon certain classes of fighting vessels. Undoubtedly we must. Battleships and large armoured cruisers owe their fitness for the line of battle not only to the formidable character of their offensive armament, but also to the fact that they carry so much external armour as will protect the people at the batteries and elsewhere from the effects of the fire of small and medium

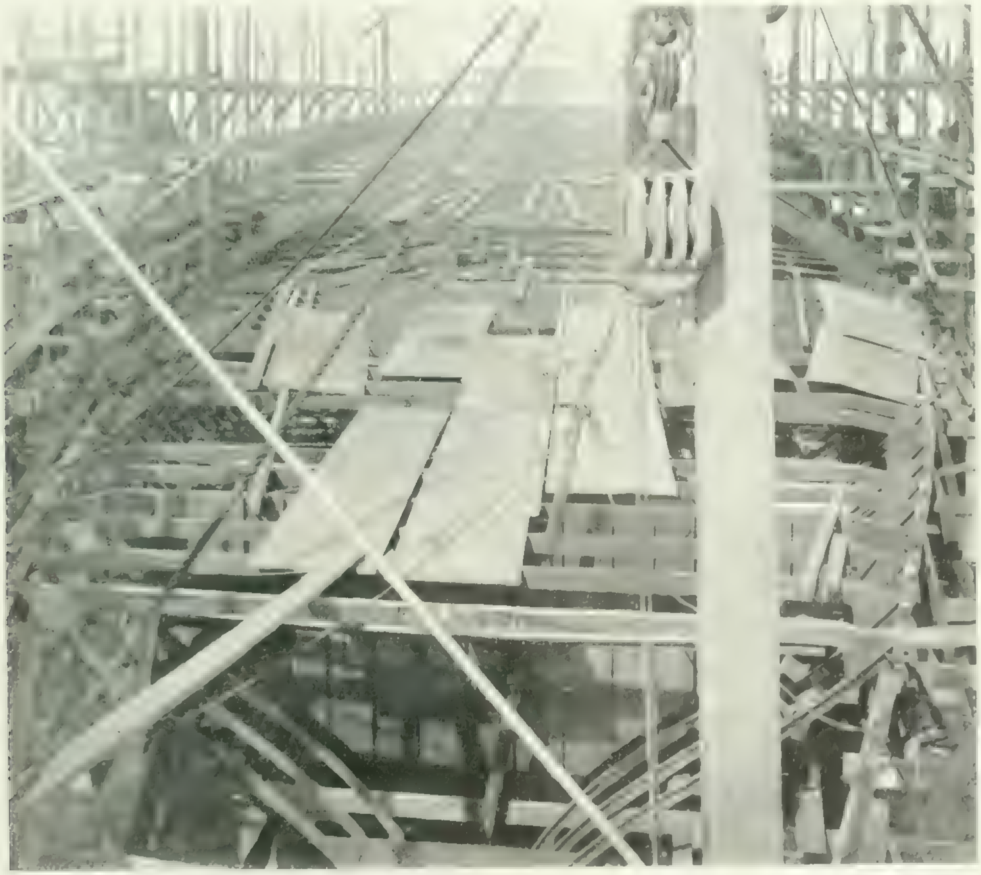

FIG. 4 SHOWS THE PROTECTIVE DECK BEAMS AMIDSHIPS IN PLACE AND THE PLATING BEING COMMENCED.

guns. That amount of armour, however, does not constitute an overwhelming burden for a big ship to carry. A craft of 14,000 or 16,000 tons displacement can have practically the whole of her hull armoured with 6-in. Krupp steel, and still retain enough buoyancy to allow of her carrying very powerful engines, an ample armament, and plenty of coal. It is when immense barbettes, heavy armament, plenty of ammunition and of 12-in. or 14-in. armour, supplementary turrets, massive gun hoods, huge conning-towers, heavily armoured ammunition-hoists, and a multiplication of thick internal bulkheads are introduced as well, that the defensive features of a ship assume undue predominance, and prejudice the offensive value of the craft. Besides, it is vain and useless thus to pile on armour. Any battleship in existence can be put out of action, if not actually destroyed, by gun-fire alone, and yet all her heaviest armour may remain absolutely intact. Even if we pile on all the armour that a ship can carry, and if we sacrifice offensive qualities entirely, we can secure only a relative degree of protection.

This being the case, what is the proper policy to be pursued with regard to the armouring of big ships ?

Do what we may, we cannot hope to keep out every projectile. Very big shells, impinging at favourable ranges and angles, will always find a way in, no matter the weight of our armour. But it has been calculated that in actions in which battleships and armoured cruisers of existing types take part, out of every forty-one projectiles discharged, thirty will be small, ten will be of medium calibre, and but one will be of so heavy a nature as to be a serious menace to modern 6-in. armour. This calculation omits from consideration every projectile of less than 3-in. calibre, and assumes that the fighting of the future, so far as fleet and fleet are concerned, must be carried on outside the limits of torpedo range. Adopting this basis of computation, we find that if we cover a ship's hull with 6-in. Krupp steel, we may reasonably hope to keep out forty out of every forty-one projectiles that shall hit her in battle. Of course it may happen, if the angle of incidence be propitious, that a 7·5-in., or even a 6-in. shell will occasionally pierce the best 6-in. armour at such ranges as those of which I speak. On the one hand, there are afloat a certain number of guns of exceptional length and muzzle-energy ; and on the other, all good armour is not equally good all over. Nevertheless, bearing in mind that guns in action are seldom quite as formidable as the same guns on the proving-ground, we may take it, I think, that all the exceptionally heavy modern armour on the hulls, and inside the hulls of ships of war, is placed there for defence against projectiles which cannot well exceed about three per cent. of the whole number of projectiles likely to strike it.

TWO VITAL QUESTIONS.

These considerations give rise to two questions. One is : Is it worth while, looking to the enormous sacrifices which must be made ere much thick armour can be carried, to carry it ? The other is : Is there no method whereby some at least of the advantages of thick armour may be secured without depriving the ship of a corresponding proportion of her most valuable fighting qualities, the purely offensive ones ?

The two questions may be dealt with together. Experience has taught us, with regard to gunnery practice, that a percentage of hits which would be contemptible against a target in peace time, would be very good indeed against an enemy in war time. Five or six years ago American naval gunnery had a deservedly high reputation. After the battle of Santiago it lost its character in the estimation of unthinking people, the sole reason being that in that action the American gunners did not make anything like so large a percentage of hits as their previous peace performances had led the unthinking people to look for. The truth, of course, is that, no matter how excellent your gunners may be,

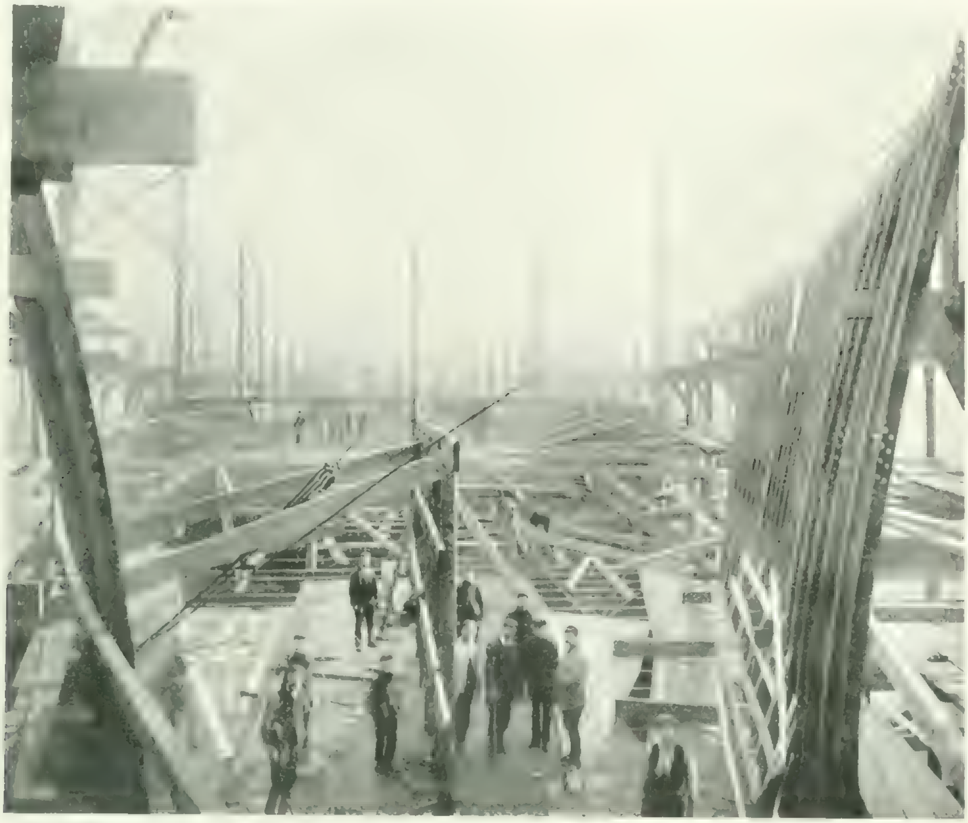

FIG. 7. THE FORWARD PROTECTIVE DECK PLATING IN PROGRESS.

you can never get them to do as well against a replying enemy as against a passive target. But it is also true that in proportion as their practice is good the reply will be bad. To make good practice, the desiderata are good guns and plenty of them, and highly trained gunners. From this it results that a heavily armed ship, with a perfectly trained and disciplined crew, should be able, to a very large extent, to keep under or confuse the fire of a ship which is less well armed, and which has an indifferent crew, even if the less well armed ship possesses great superiority in the matter of armour. I think, in short, that heavy armament and good gunnery will always compensate, largely if not absolutely, for lack of very heavy armour. It is only another way of expressing the generally accepted formula that a vigorous offensive is the best defence. That formula is the secret of all effective strategy; it is hardly less the secret of all effective tactics.

THE SECURITY OF A SHIP AS A FLOATING PLATFORM.

I need not say much about habitability, security as a floating platform, seaworthiness, and ability to use the guns under all conditions of weather. These are qualities which can be neither sacrificed nor paltered with in vessels which are intended for cruising as well as for fighting work—for the kind of work, in fact, which must be done by British battleships and armoured cruisers in war time. But it may be desirable to point out that the security of a ship as a floating platform does not necessarily depend upon the thickness of her external armour at and near the waterline. When a modern battleship has nearly empty bunkers, has expended a part of her ammunition, and has

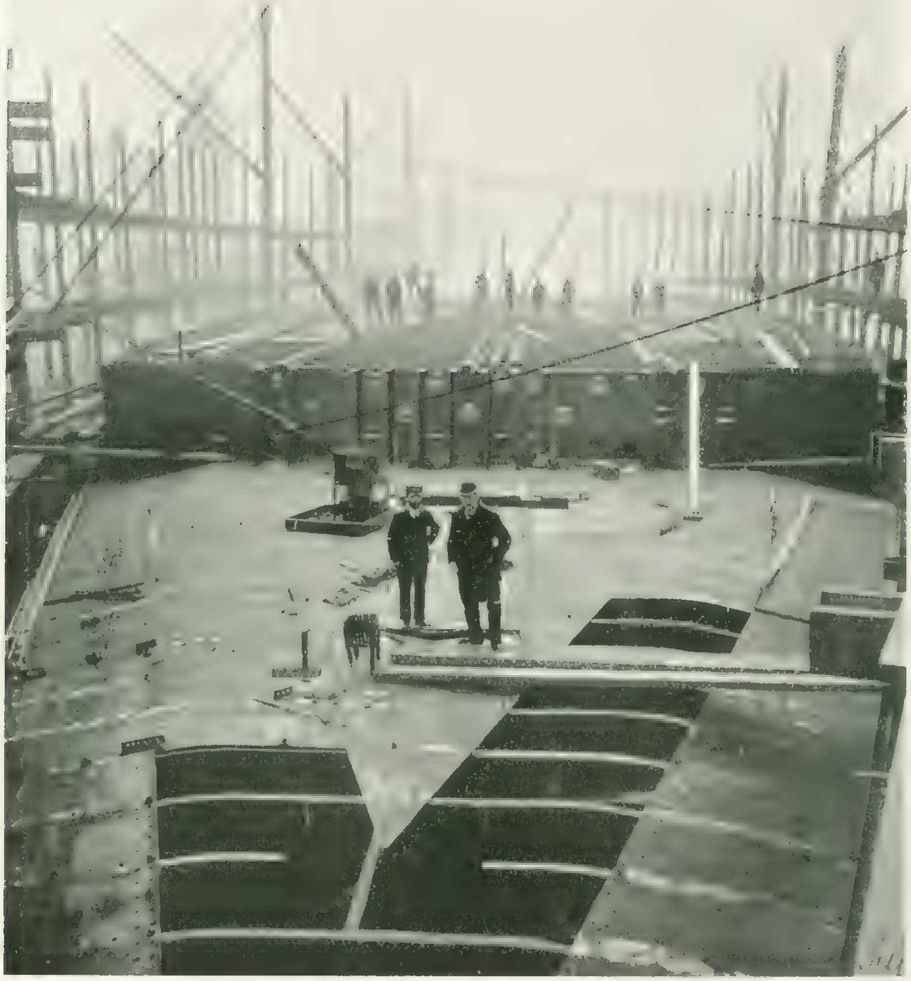

FIG. 6. ANOTHER VIEW OF THE FORWARD PROTECTIVE DECK, SHOWING PLATING IN PROGRESS. THE MAIN DECK BEAMS ARE SEEN AMIDSHIPS.

hoisted out her boats, or had them destroyed, her side armour, especially on the windward side, will, in the majority of cases, be above water altogether. Such will be a very probable condition of affairs if she goes into action after a long and hot chase. On the other hand, a vessel carrying the maximum amount of coal in her bunkers, more coal, perhaps, on deck, full magazines, and all her boats, may easily have her belt, if it be a narrow one, entirely submerged, especially on the leeward side. Such will be a very probable state of affairs if she goes into action unexpectedly, within a few hours of leaving port. An armoured belt, therefore, unless, indeed, it be something much broader than the ordinary waterline belt, may be altogether inefficacious, even while it remains intact. The security of a ship as a floating platform may, of course, be bettered by armouring her at the waterline ; yet there, as elsewhere, the use of thick armour over a large superficies can be indulged in only at the sacrifice of offensive qualities ; and, upon the whole, the desired end can, I think, be attained with more certainty by other means. Six-inch side armour, reinforced near the waterline by a system of cellular subdivision of the hull, by a belt of "cellulose" or some other absorbent material, by the usual armoured deck (the actual value of which, however, has yet to be determined), and by a judicious arrangement of coal bunkers, ought to effect the object in view as completely as it can be effected. The employment of such devices does not involve the overburdening of the ship, and gives a far wider area of protection than can be given by the application of 10-in. or 12-in. armour.

COAL AND AMMUNITION CARRYING CAPACITY.

I come next to coal-carrying, and ammunition-carrying capacity. These are highly important qualities. Without a plentiful supply of coal, engine-power may be neutralised; without a plentiful supply of ammunition gun-power may be worthless; so that coal and ammunition must take rank among the most essential of offensive factors. But, although they are so important, so vitally important if you will, they cannot be placed in quite the same category as engine-power, and gunpower. And for this reason: when a ship is commissioned in war time, she has within her a certain amount of engine-power, and a certain amount of gun-power; and, in ordinary cases, these cannot be added to or improved during the whole campaign, unless the vessel be laid up and rendered ineffective for a long period. They represent a permanent installation. But it is always contemplated that coal and ammunition must run short from time to time; and, no matter how great a ship's bunker and magazine capacity may be, bunkers and magazines must be replenished sooner or later. While, therefore, it is an undoubted advantage for a fighting ship to be able to stow plenty of fuel, powder, and projectiles, it does not follow that, because she possesses enormous stowage room, she will always have the generous supplies which she may need at a given moment. In fact, she can never be sure of having them at all, unless there be good organisation behind her, with a proper utilisation of coaling-stations, fast colliers, ammunition storeships, and methods of rapid coaling. The ship with large capacity will be less continuously dependent upon the excellence of this organisation than will the ship with less capacity; but it is only a question of degree; and it seems to me that with foresight, good management, and the facilities which can be furnished by the genius of the inventor, a man-of-war, even if provided with only moderate bunker and magazine capacity, may well be kept fed with coal and ammunition, so that she shall seldom be in danger of falling short.

EFFECTIVE COALING A PROBLEM TO BE FACED SQUARELY.

But to attain that consummation, we must buy or build fast colliers of considerable size, and must provide them with appliances which shall enable them to coal men-of-war with safety, and a certain modest degree of speed, as well at sea as in port. We must also buy or build fast ammunition-supply ships. And the vessels must be fast enough to keep up with any squadron that can be sent to sea. This problem has never yet been faced squarely. Several years ago I watched some experiments in coaling at sea. A man-of-war took a collier in tow, and, by means of tackles from her mizen mast to the foremast of the collier, improvised a kind of sagging aerial railway along which she hauled infrequent bags of coal on to her quarter-deck. When the tow-line slackened, as happened sometimes, the bag which was upon its way was plunged into the water, and half the coal was washed out of it, while the force of the sea checked the bag itself, and almost tore it to pieces. Of course, that primitive arrangement was terribly tedious and unsatisfactory; yet how much better would it have worked if the collier, instead of the man-of-war, had been made the towing ship. In that case, supposing the bags to have touched the water, they would have been helped on their way, instead of

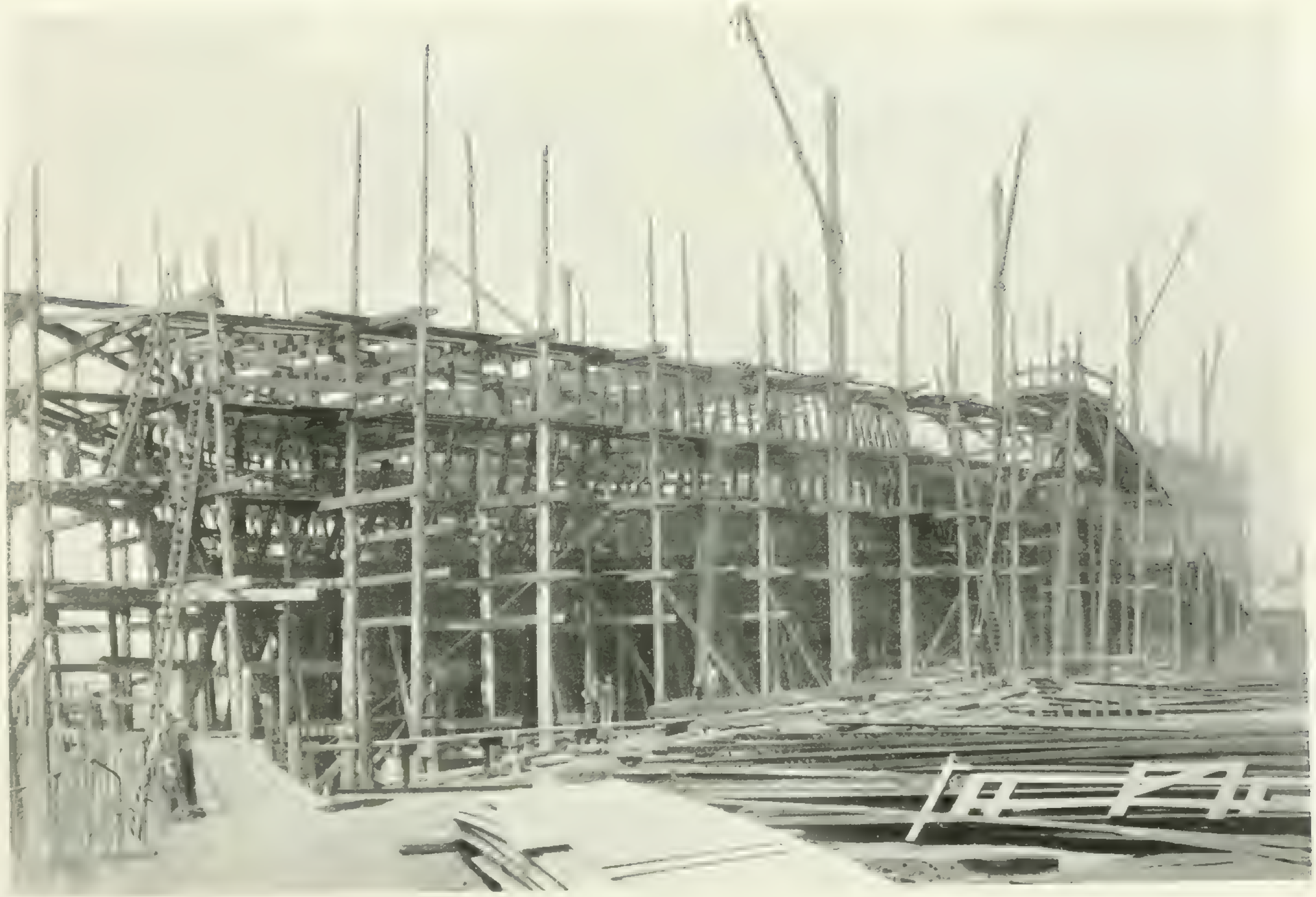

FIG. 7. READY FOR THE OUTSIDE PLATING.

When completely framed, or even in some cases when partially so, the outside plating is gone on with [illegible]; and the man-of-war would have coaled over the forecastle, and not over the nice clean quarter-deck. I believe that it did not occur to anyone concerned to suggest the making of the change. Possibly the collier in question had not power sufficient to enable her to tow the man-of-war. But colliers capable of towing can be built, and the rough appliances of which I speak can be improved upon. I recall the incident merely in order to show how little serious study the important question of coaling under way had received in the Navy at the time. It is still too much neglected. Until we devote serious attention to it we shall never be able properly to utilise the speed of our fast ships, and shall be obliged, as heretofore, to turn them into floating coal yards and perambulating Woolwich Arsenals, to the prejudice of their speed and their general fighting qualities.

Engine-power and gun-power are not qualities which can be similarly supplemented from outside.

SPEED AND GUN-POWER.

Speed is a strategical as well as a tactical factor. It facilitates the making of rapid and certain strategical combinations; it endows the ship possessing it with the inestimable advantage of being able either to force or to refuse an action with a slower enemy; it confers upon the faster vessel the power of choosing her own fighting distance, while also enabling her to select and retain for herself the best fighting position; it allows a craft of inferior force to venture in war time with safety into waters where, if she were slower, she would not dare to cruise at all; and it gives its owner the best opportunities of collecting intelligence. Speed, therefore, is not less valuable to the battleship than to the cruiser, and not less valuable to the protected cruiser than to the armoured one. In this country, nevertheless, the importance attached to mobility is so secondary that the return which is now presented annually to the House of Commons of the fleets of the leading Powers makes no mention whatsoever of speed, although it specifies the date, the displacement, and the armament of every vessel described. The obvious conclusion is that those who move for the return are of opinion that it matters little whether a ship can steam at twenty-five knots or only at ten knots, provided that she be big, and not too old, and that she carry heavy guns. In truth, it is not of much use to be able to cook your hare unless you can first catch him. Speed is not only one of the first, but also one of the most indispensable of offensive qualities. In importance it ranks with gun-power alone.

BRITISH SHIPS CRITICISED.

All thoughtful and competent students of history must agree that, in men-of-war, defensive qualities cannot for value compare with offensive ones, and that it is wise, when compromise is obligatory, to make greater sacrifices for the sake of offence than for the sake of defence; yet for more than half a generation we have pursued what seems to be a contrary policy, with the result that to-day most of our best and most costly ships are demonstrably weaker in the qualities of speed and gun-power than many a foreign ship of much less pretentious and expensive character. It is useless for Admiralty apologists to urge, by way of retort, that those of our ships which I make bold to criticise possess compensating advantages. Nothing can compensate for deficient speed and striking power. It is also useless for them to plead that our inferior vessels are, for the most part, older than the superior craft of foreign nations. I do not choose our worst and oldest ships, but our best and newest, for comparison with other vessels of about the same size; and if our best and newest be inferior to the best and newest of other powers, the obvious conclusion is either that the Admiralty, up to the time of Sir W. H. White's resignation, was neglectful of its duty, or that the naval architects, engine designers, and others who endeavoured to carry out the

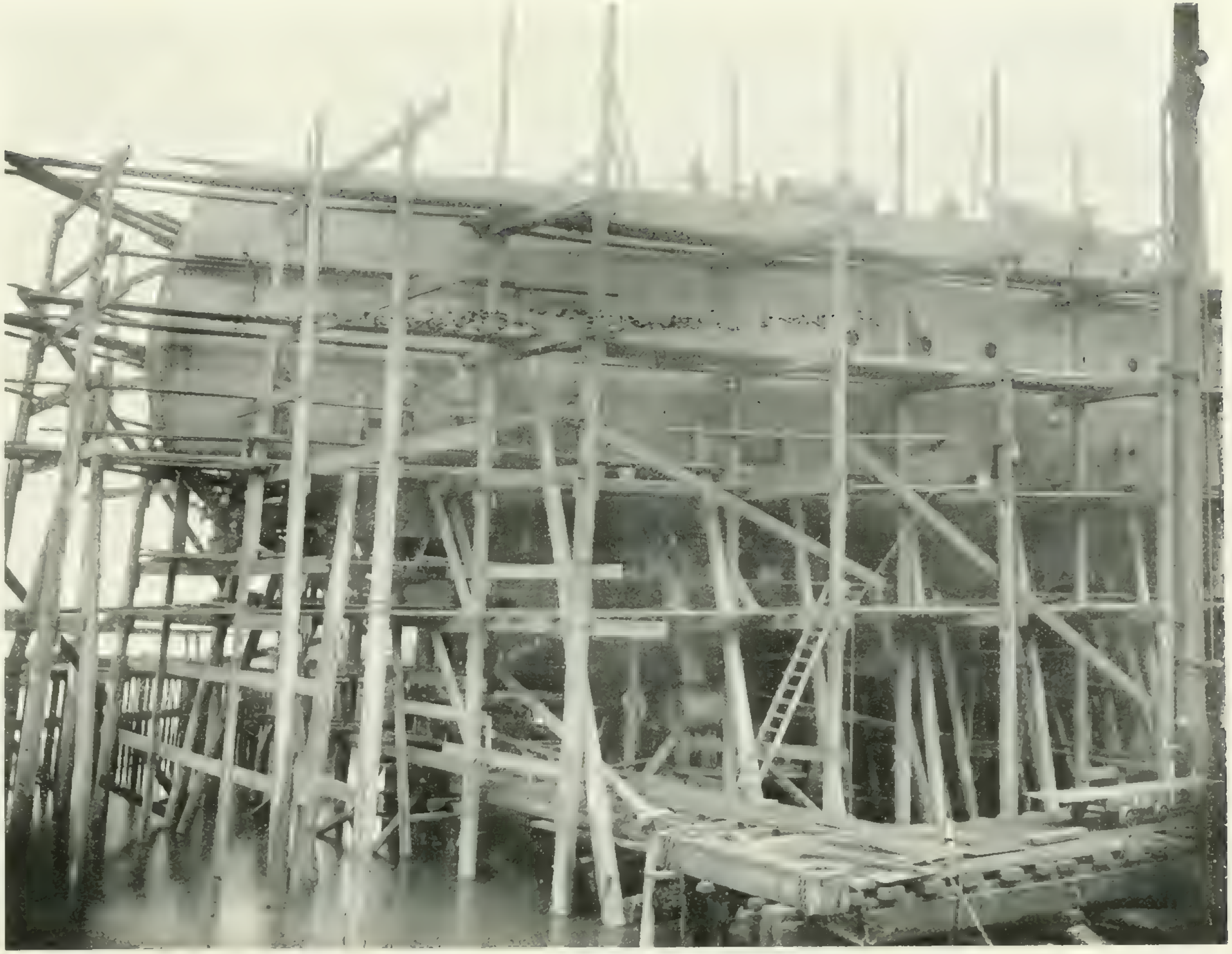

FIG. 8. NEARLY READY FOR LAUNCHING.

When completely plated and riveted, the warship is ready for launching, in order that she may be taken to a crane and have her machinery and guns fitted on board.

Admiralty's directions were inferior in ability to those of their competitors who worked for foreign Governments, and that, instead of leading the rest of the world, they merely followed it at a distance.

Let me, by way of example, compare our own battleships of the *King Edward VII.* class with the American battleships of the *New Jersey* class. The former, by-the-bye, were designed after the specifications of the latter had been published. Here are some parallel statistics :—

	"King Edward VII."	"New Jersey."
Normal displacement, tons ...	16,350	15,000
Maximum speed, knots	18·5	19·0
[illegible]	[illegible]	[illegible]
Main and secondary armament	[illegible] 4 9·2-in. (45 cals.) 10 6-in. (45 cals.)	[illegible] 8 8-in. (45 cals.) 12 6-in. (50 cals.)
Weight of double broadside, lb. ...	5,920	6,600
Muzzle-energy of double broadside, ft.-tons (about) ...	286,600	334,000
Weight of double broadside, per ton of displacement, lb.	·362	·440
Muzzle-energy of double broadside, per ton of displacement, ft.-tons (about)	17·5	22·2

Again, let me more briefly compare our battleships of the *Duncan* class with the Italian battleships of the *Benedetto Brin* type, and with the battleships of the *Constitución* class, recently launched for Chili, but since announced as for sale :—

	"Duncan."	"Benedetto Brin."	"Constitución."
Normal displacement, tons ...	14,000	13,427	11,800
Maximum speed, knots	19	20	21
Main and secondary armament ...	4 12-in. 12 6-in. (45 cals.)	4 12-in. 4 8-in. 12 6-in.	4 10-in. (45 cals.) 14 7·5-in. (50 cals.)
Weight of double broadside, lb. ...	4,600	5,440	4,800
Weight of double broadside, per ton of displacement, lb.	·328	·405	·406

Far be it from me to assert that in no respect is the *Duncan* superior to her rivals. But in the important matters of speed and gun-power she is obviously inferior, both actually and relatively.

CONCLUSIONS.

I do not want to pursue the statistical comparison, and to apply it in turn to armoured cruisers, and to unarmoured cruisers of the various classes. To do so would be very tedious, and would occupy too much space. Moreover, in his paper on "The Lines of Fast Cruisers," read at the recent meeting of the Institution of Naval Architects, Vice-Admiral Fitz-Gerald has said something on the subject, and has compared the Russian *Bayan* with the British armoured cruisers of the "County" class, very much to the disadvantage of the latter. It will suffice to state general conclusions. These are that while, as a rule, though not always, our armoured cruisers are faster than their foreign rivals, they are at the same time very much less heavily gunned. Indeed, their weight of double broadside per ton of displacement is, speaking broadly, only about two-fifths of that of their possible competitors in other navies. As for our unarmoured cruisers, they are very much more unsatisfactory, for neither in speed nor in gun-power do the majority come up to the standards which have been adopted by other maritime nations. In fact, it really looks as if no effort had been made to give them adequate gun-power. And in this connection I cannot forbear quoting, without comment, what Sir W. H. White said about the *Powerful* and *Terrible* in the *Times* of January 22nd last. Speaking of the fact that these huge vessels had been intended by way of reply to certain foreign cruisers, he wrote :—

> The total weight devoted to the armament and its protection greatly exceeded the corresponding weight in the *Rossia*. The *Powerful* was made the stronger fighting machine, although she carried fewer guns and each discharge of her whole original armament throws a less weight of metal. Recently four additional 6-in. guns in casemates have been added to the armament of both the *Powerful* and *Terrible*. This has been interpreted by the critics as an acknowledgment that the original armament was considered to be weak. A more correct statement would be that, while the original armament was sufficient for its intended purpose, it was found possible when the ships were completed to carry these extra guns and their protection, while practically maintaining the designed draught, speed, and stability.

Gun-power is so immensely important that I think we ought never to sacrifice it again as we have sacrificed it in the past. Our future large battleships ought to be able to throw at least ·420 lb. of metal per ton of displacement ; our future large armoured cruisers, at least ·300 lb. ; and our future large unarmoured cruisers at least ·280 lb. ; and, at the same time, the vessels ought not to be inferior in speed to corresponding foreign ships. Those figures seem to mark the limits of the concessions which may justifiably be made at present to armour, coal and ammunition capacity, and the other qualities which it is sought to combine in a serviceable man-of-war of the first-class in each category.

The Lodge-Muirhead System
OF
"Wireless" Telegraphy

BY

H. C. MARILLIER.

Continuing the series of articles recently published in this magazine under the heading "The Development of 'Wireless' Telegraphy," the author now describes the system which Sir Oliver Lodge and Dr. Muirhead have been engaged for some years past in perfecting, and which has at length been put into practical working by the inventors. Sir Oliver Lodge's early work in connection with Hertzian waves and "wireless" telegraphy has already been discussed,* but its later developments, and especially the mechanical improvements due to Dr. Muirhead's experience of telegraphic work, have been kept back pending the completion of the whole system.—ED.

FUNDAMENTAL PRINCIPLES.

THE Lodge-Muirhead system is essentially a syntonic system. That is to say, following up the lines on which Sir Oliver Lodge first started, in 1894 and earlier, the sender and receiver are so tuned that the waves emitted by the former, however feeble they may be on their arrival at the receiving instrument, exert a cumulative effect, just as sound waves do in the case of a suitable resonator. Lodge's first electrical demonstration of this effect was with the tuned Leyden jars, in which, by properly adjusting the two circuits, a discharge in one jar set up oscillations and an overflow in the other. The radius of transmission is, however, very small with capacities of the Leyden jar type, and Lodge saw that the way to extend it was not only to increase the size of the jars but to open them out so that the two coats were extended parallel or continuously in space, with a spark gap between them. In practice this arrangement has been reduced to an aerial capacity, usually a wire framework designed to catch the wind as little as possible, and a second capacity lying on the earth, which in favourable situations may be the earth itself. Between these two at some point in the vertical wire connecting them, is the spark gap, served by a Ruhmkorff coil; and between the spark gap and the lower capacity or earth plate, are placed an inductance coil and a condenser, both adjustable, which serve for tuning the sending circuit or radiator to the required pitch. This method of tuning, which can be modified to suit particular circumstances, and which for very close screening is supplemented by a variety of more elaborate devices, is one of the essentials of the system, and dates from the earliest Lodge patents of 1897. There are two other prominent features which, although they have been adopted by different inventors, are nevertheless claimed in the patents of 1897. These are first an ironless induction coil, or transformer, in the receiving circuit, for multiplying the electromotive forces and so intensifying the action on the coherer: and secondly a condenser shunt in the coherer circuit, the purpose of which is to give it a definite time period by eliminating the disturbing influence of the battery and receiving instrument. The circuit through these is closed all the time, and therefore oscillations could work themselves up and cause an overflow through the coherer as soon as they are strong enough. This condenser shunt is used in one form or

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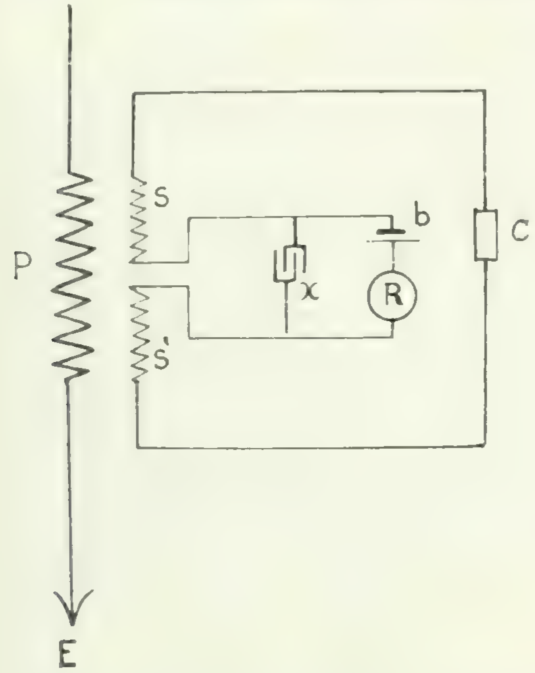
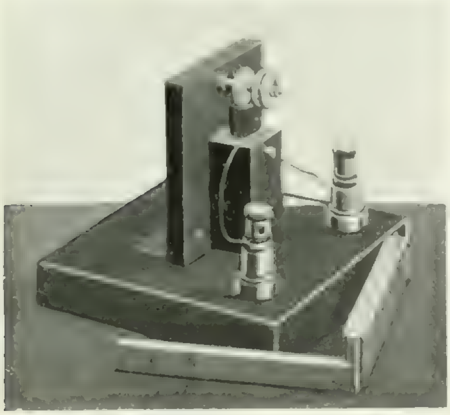
* PAGES' MAGAZINE. Vol. I. No. 3. Page 263.



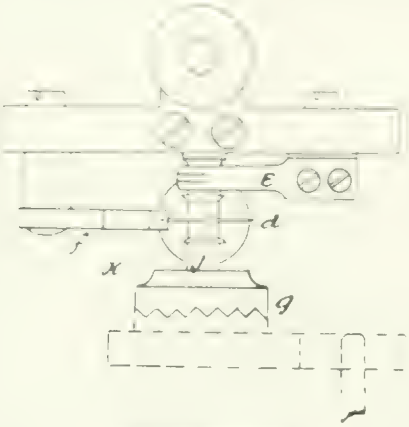
another by the Marconi Company and by the Admiralty, in their modification of the Marconi system. The accompanying diagram shows the method of connection adopted in the Admiralty system ; the secondary of the transformer *s s'* is divided in half, and the condenser, *x*, which shunts the battery, *b*, and the relay, R, is inserted in the middle. The coherer is shown at *c*. In the Lodge system it has been found best to have two condensers, one in the transformer secondary circuit shunting the battery and receiving instrument, as described (there is no relay), and the other as shown at x'.



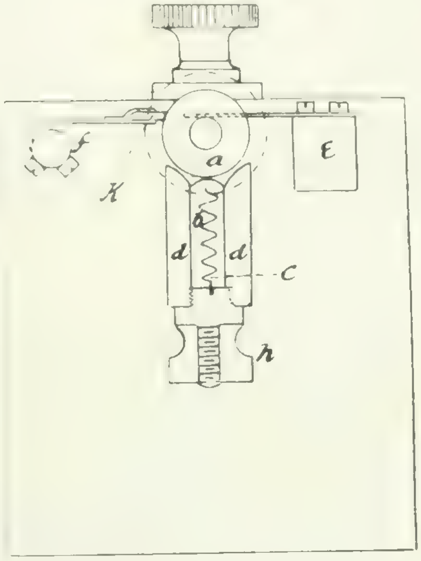
LODGE-MUIRHEAD COHERER.

NEW DETAILS.

The foregoing are more or less fundamental features in the Lodge-Muirhead system, which, however, as already explained, admits of special modifications to suit circumstances ; but the practical workability of the system depends quite as much upon its details as upon fundamental features. Amongst the more important new details is the coherer, which departs entirely from the type commonly in use, and consists of a small steel disc rotating in light contact with a column or globule of mercury contained in an ebonite tube, and covered with a thin film of mineral oil. The impulse of received waves breaks down the film of oil and establishes



COHERER—PLAN.

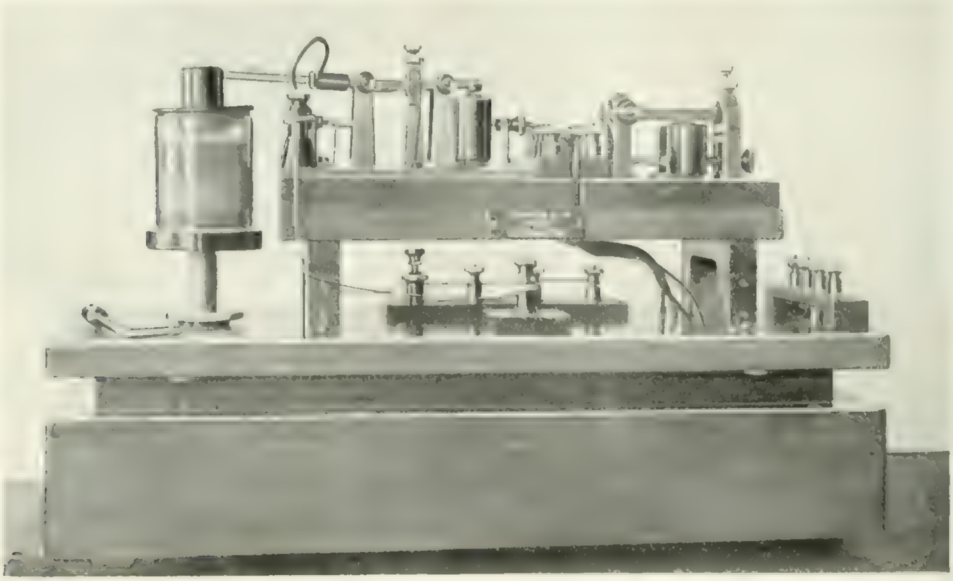


COHERER—SECTIONAL ELEVATION.

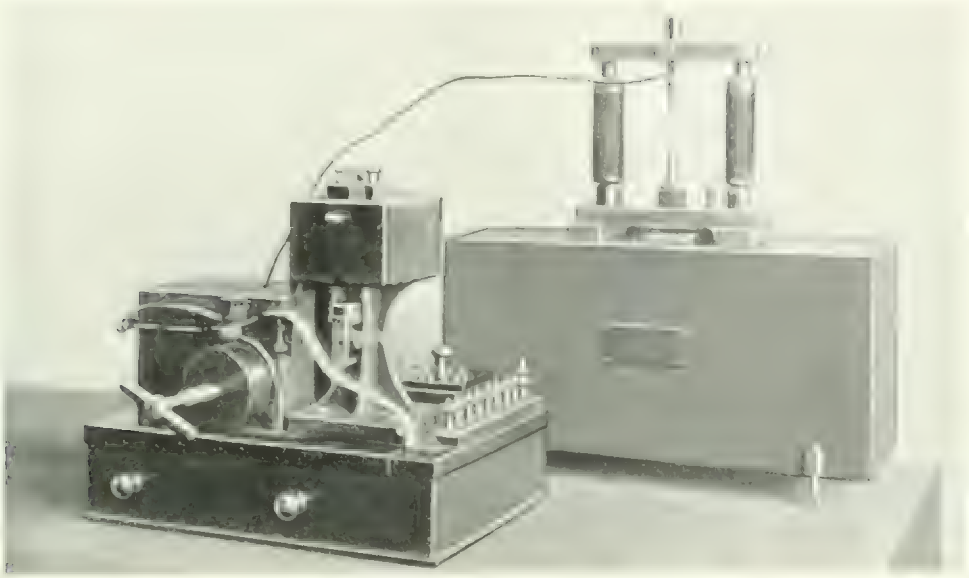
momentary contact with the mercury sufficient to complete the circuit and enable the current from a local cell to operate a siphon recorder. The rotation of the disc, which is geared by ebonite wheels to the clockwork motion of the recorder, destroys the contact instantly without the intervention of any tapping apparatus, and this is a great gain both in simplicity and effectiveness. A felt pad lightly touching the steel disc cleans its edge of dust before and after contact, and renders it very certain and sensitive in action. In fact for sensitiveness this coherer is very difficult to surpass, and for certainty it is an improvement upon most types of filings coherers ; although the filings coherer used until recently by Messrs. Lodge and Muirhead, with needle points instead of plugs, gave wonderfully good results also. A diagram is given here showing the construction and connections of the new coherer.

It has already been mentioned that the coherer acts directly on a siphon recorder, without the intervention of a relay, and connected with it is a potentiometer for regulating the difference of potential at its terminals. In practice half a volt is seldom if ever exceeded, and for many purposes the e.m.f. is as low as ·03 volt. The ratio of the tranformer coils is about 1 to 8.

The chief innovations in regard to the signalling apparatus is the form of interruptor devised by Dr. Muirhead, and called a " buzzer," and the use of an automatic signalling machine, where preferred, in place of the hand-operated Morse key. The " buzzer " consists of a pair of telegraphic sounders, or electro-magnets, cross-coupled so as to act reciprocally during the holding down of the Morse key, or whilst the automatic machine is giving its signals corresponding to the perforations of a running tape. To the armature of one of the sounders an aluminium arm is fixed, with a copper rod at the end, which dips into a vessel of mercury, and makes and breaks contact with the mercury as the arm is actuated by the armature. This make-and-break governs the spark coil, so that the function of the " buzzer " is to break up the signals of the key automatically into a rapid succession of sparks, the frequency of which can be adjusted to give the best results in transmission. In other words, the long and short signals of the Morse key are translated by the " buzzer " into oscillations of an appropriate frequency, which in their turn are translated back by the siphon recorder into long and short signals on a running tape. The combined apparatus is so sensitive that if the rate of sparking is at all too low the long signals on the tape show a series of small ridges corresponding



" BUZZER " INTERRUPTOR.



CONNECTION MADE TO RECEIVING SET.

to the number of sparks, whereas if it be perfectly right the siphon needle is held over and the signal consists of a straight line deflexion. The extraordinary sensitiveness of the recorder and coherer combined enable the operators to detect the slightest inequalities or uncertainty in the working of the transmitter, and is most useful in studying the changes brought by every variation in the modes of signalling.

The writer has seen and studied the working of the new system at Dr. Muirhead's works, near Beckenham, in Kent, where an experimental range has been constructed over 8½ miles of chalk downs, with a difference in level of nearly

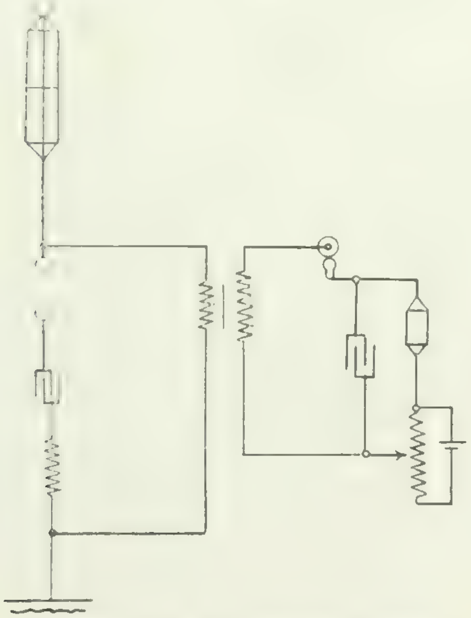


DIAGRAM OF THE LODGE-MUIRHEAD RECEIVING CONNECTIONS.

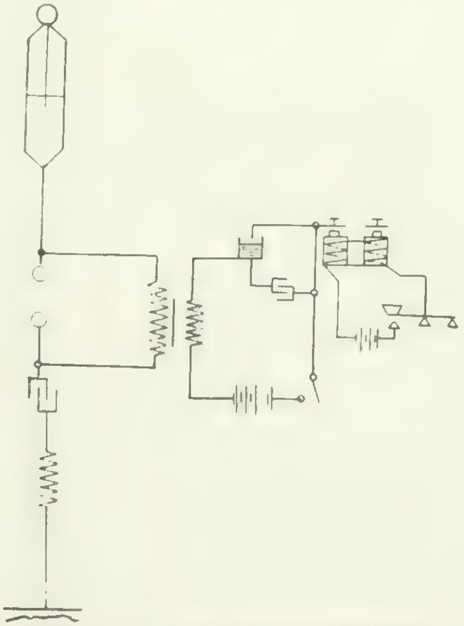
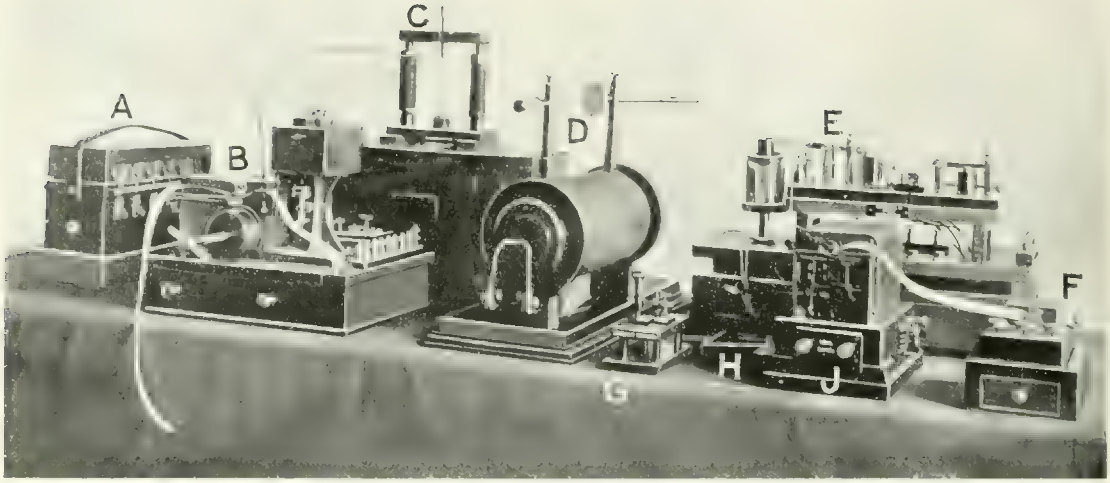


DIAGRAM OF THE LODGE-MUIRHEAD TRANSMITTING CONNECTIONS.

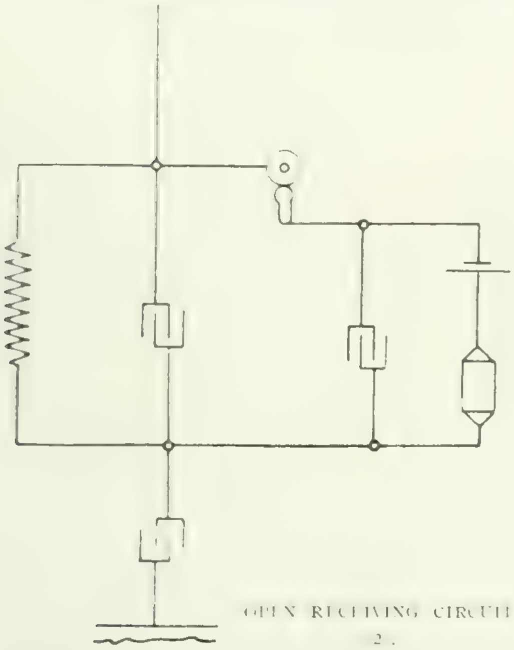


COMPLETE LODGE-MUIRHEAD SET.
A = 12 volt Secondary Battery. **B** = Receiving Set. **C** = Spark Rods in Frame. **D** = 10-in. Spark Coil. **E** = "Buzzer." **F** = Perforator. **G** = Morse Key. **H** = Primary Switch. **J** = Auto Transmitter.

300 feet between the two stations. Owing to the insulating properties of chalk, this range is probably equivalent to 50 miles at sea. The system has, however, been actually tested over longer distances, both in the Irish Channel and under Admiralty conditions over the official range of 62 miles between Portland and Portsmouth. In all cases it has given the utmost satisfaction, and with the close screening devices introduced, the inventors are satisfied that they can eliminate outside interference from other stations outside a 10-mile radius. Within that distance the problem is more difficult, and so far no one can boast that the difficulties have been absolutely overcome.

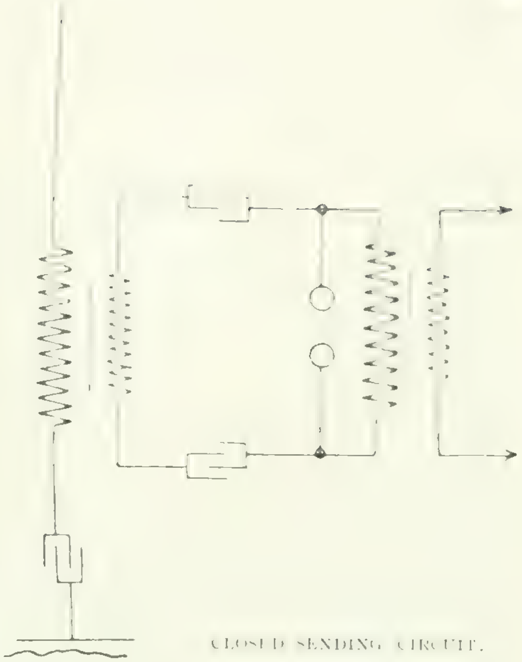
For ordinary sea-going work, and communication between ships and the shore, an open system is almost necessary, at present, because

MORSE KEY AND AUTOMATIC SIGNALLING APPARATUS.



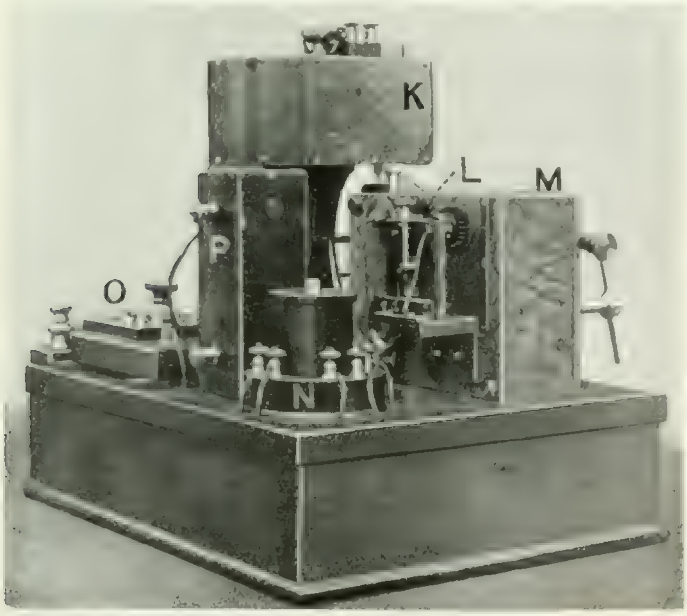
OPEN RECEIVING CIRCUIT

2.



CLOSED SENDING CIRCUIT.

of the great variety of range and the complication which would be necessary if every ship had to tune its system specially for each station. Whilst the number of vessels arriving and signalling at one time is small, confusion need not arise to any great extent, although even now interference is common enough; but what would happen when a larger number of ships were equipped, and signals were flying thick between them and the shore stations, it is difficult to foresee. In that case close syntonic signalling would probably become necessary. It is towards this question that Messrs. Lodge and Muirhead have been devoting their energies, rather than towards the bridging of enormous distances, and in the practical development of the details necessary to this end, as well as in the perfecting of the signalling apparatus, the credit for the success of the new system rests mainly with Dr. Muirhead. It is some reward for his labour that the first installation of "wireless" telegraphy adopted by one of the cable companies, that on board the two new repairing ships of the Eastern Extension Telegraph Company, should have been allotted to the Lodge-Muirhead Wireless Telegraphy Syndicate, after a careful consideration of the different competing systems at present in vogue.



BACK VIEW OF RECEIVING APPARATUS.

K = Siphon Recorder. **L** = Coherer without case. **M** = Clockwork.
N = Change over Switch. **O** = Potentiometer. **P** = Transformer.

OUR MONTHLY BIOGRAPHIES.

SIR WILLIAM LAIRD CLOWES.

SIR WILLIAM LAIRD CLOWES, who writes in the present number of PAGE'S MAGAZINE on "The Relative Importance of Offensive and Defensive Qualities in Men-of-War," is widely known as a naval critic, as well as a historical and miscellaneous writer.

Eldest son of the late William Clowes, a Registrar in Chancery, and born in 1856, he was educated at Aldenham, King's College, London, and Lincoln's Inn, but abandoned law for journalism and other forms of literature, and, about the year 1882, began to interest himself specially in matters connected with the Navy. For a number of years he acted as naval correspondent for the *Standard*, the *Daily News*, and the *Times*, successively, and in that capacity was present at eight or nine of the annual naval manœuvres, as well as at many foreign naval functions. He also contributed on naval subjects to the *Daily Graphic*, when that paper was first started, and his articles, republished under the title of "The Needs of the Navy," were chiefly responsible for the great increase in the Navy Estimates for 1894, when they leapt at a bound to upwards of three millions more than they had ever before been in time of peace. A year or two earlier, with a view to calling attention to the strategical situation in the Mediterranean, he wrote for the *Engineer* a naval serial story, which subsequently had a great success as "The Captain of the *Mary Rose*." A little later he again aroused popular interest in the state of the Navy by the articles which, over the signature "Nauticus," he wrote for the *New Review*, the *Fortnightly Review*, the *Indépendance Belge*, and other periodicals. In 1896 he first issued "The Naval Pocket Book," a handy annual of statistics relating to the navies of the world. Ere that time, however, he had begun to devote himself particularly to the subject of naval history. Among the fruits of his labours in that direction are "The Royal Navy, a History from the Earliest Times to the Death of Queen Victoria" (seven volumes, 1897-1903), and "Four Modern Naval Campaigns" (1902). In recognition of his work for the Navy he was knighted on the occasion of the King's coronation.

Sir William Laird Clowes is the only English gold-medallist of the United States Naval Institute, and is also a Fellow of King's College, an Associate of the Institute of Naval Architects, and an Honorary Member of the Royal United Service Institution.

Photo by Elliott and Fry.]

SIR WILLIAM LAIRD CLOWES.

MR. MICHAEL LONGRIDGE, M.A., M.INST.C.E., M.I.MECH.E.,

[illegible]

MR. LONGRIDGE [illegible] He [illegible] the Bedlington Iron Works in Northumberland, a concern famous in its time for heavy forgings. His father, James Atkinson L[illegible] George Stephenson and a civil engineer with a large practice, principally on railway works at home and abroad. He is remembered chiefly as the inventor of the wire gun now universally adopted in the British Navy.

Mr. Longridge was born at Bedlington in 1847. He was educated at Radley and at Trinity College, Cambridge, where he graduated in 1869, having a short time before been articled to his father as a civil engineer. After leaving Cambridge he was employed in the locomotive department of the Fell Railway over the Mont Cenis, in survey work in Italy, in railway construction in Sweden, and afterwards as chief assistant in his father's office at Westminster. In 1878 he became chief engineer of the Engine and Boiler Insurance Company in Manchester, and in this capacity has gathered the experience and knowledge which make his opinion of so much weight. His technical knowledge and mastery of the problems and phenomena connected with the application of steam power, together with the thoroughness and scientific accuracy with which his experiments have been conducted, have rendered his tests of the efficiency and economy of steam engines of the greatest value to steam users. His marvellous powers of early diagnosis have enabled him on numerous occasions to prevent disaster, while the mass of pathological material he has gathered and classified make the volumes of his annual reports a mine of information and of immense value to the student of engineering problems. In his official capacity Mr. Longridge is responsible for the safety of over twenty thousand steam boilers and many thousands of steam and gas engines, dynamos, and electric motors. Always a consistent opponent of compulsory boiler inspection by Government officials, Mr. Longridge, by his energy and trenchant arguments, has been conspicuously instrumental in preserving to British manufacturers the freedom they enjoy from cast-iron rules and red tape administration in the working of their boilers. It is impossible for such a man to be in daily contact with engineering problems without becoming the author of many improvements which have not been without influence on the engineering and boiler-making trades. Personally, Mr. Longridge is extremely youthful-looking for his age, and finds his chief enjoyment in the interests of his large family and in playing the violin.

In 1874 he became an associate of the Institute of Civil Engineers, being elected a member in 1880. In this year, also, he became a member of the Institute of Mechanical Engineers, and has recently been elected a member of the Council.

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MR. MICHAEL LONGRIDGE, M.A., M.INST.C.E., M.I.MECH.E.

NOTES AND NEWS.

Washing Plant at the De Beers Mines.

OUR illustrations show the washing machines in which the disintegrated blue ground from the Kimberley Mine is put through the first stage of concentration. The process is thus described by Mr. Gardner F. Williams, M.A., the general manager of the De Beers Consolidated Mines, Ltd.: "The ground is dumped from the trucks into hoppers, at the bottom of which are small revolving tables upon which the ground is divided and fed automatically into two revolving cylinders. This automatic feeder, which was devised by Mr. Robeson, late mechanical engineer to De Beers Company, not only divides the ground equally between two rotating washing machines, but delivers it regularly, so that the machines cannot become overcharged, which would result in loss of diamonds. After leaving the automatic feeders, the ground is mixed with puddle (the name applied to the thick muddy water which flows out of the washing pans) and a quantity of clear water is added. This mixture serves to bring the fresh supply of blue ground in pans to the proper consistency for washing, for experience proves that diamonds and the heavy minerals with them separate from the mass of lighter material much better in a fairly thick puddle than in comparatively clear water. From the chutes below the feeders the mixture flows into a revolving cylinder covered with perforated steel plates with holes 1¼ in. in diameter. All lumps larger than the holes pass out of the end of the cylinder, and are carried by a pan conveyor to crushing rolls for further treatment. Worthless stones carried in the ground are picked out by hand as the lumps move along on the conveyor.

"The pulverised ground which passes through the screen holes of the cylinders is fed into shallow circular pans, divided so as to form an annular space, four feet in diameter, between the outer and the inner rim. Here the ground is swept around by revolving arms attached to a vertical shaft, and carrying wedge-shaped teeth. These teeth are set to form a spiral which forces the diamonds and other heavy minerals to the outer side of the pan, while the lighter material flows out of the discharge situated upon the inner rim. Fifty per cent. of De Beers ground, when well pulverised, will pass through a screen with holes $\frac{1}{16}$th of an inch square, and 66 per cent. of Kimberley ground will pass through the same screen. The big pieces of hard rock, which were brought out of the mines only a few months before, have crumbled almost to dust, which, during every working day in the year, passes through the pans in a flowing stream for ten hours a day, leaving its treasure behind. When the bare statement is made that nearly five million truck-loads, or more than four million tons of blue ground, have been washed in a year, the mind only faintly conceives the prodigious size of the mass that is annually drawn from the old craters and laboriously washed and sorted for the sake of a few bucketfuls of diamonds. It would form a cube of more than 430 feet, or a block larger than any cathedral in the world, and overtopping the spire of St. Paul's, while a box with sides measuring two feet nine inches would hold the gems."

WASHING PLANT, DE BEERS DIAMOND MINES.

Notes and News.

Business and Professional Notes.

[illegible] established by the Phosphor Bronze Company, Ltd., at Bagot Street, Birmingham, for the production of castings to patterns or drawings in alloys of Phosphor Bronze ("Cogwheel" and "Vulcan" brands), Gun Metal, Aluminium, etc.

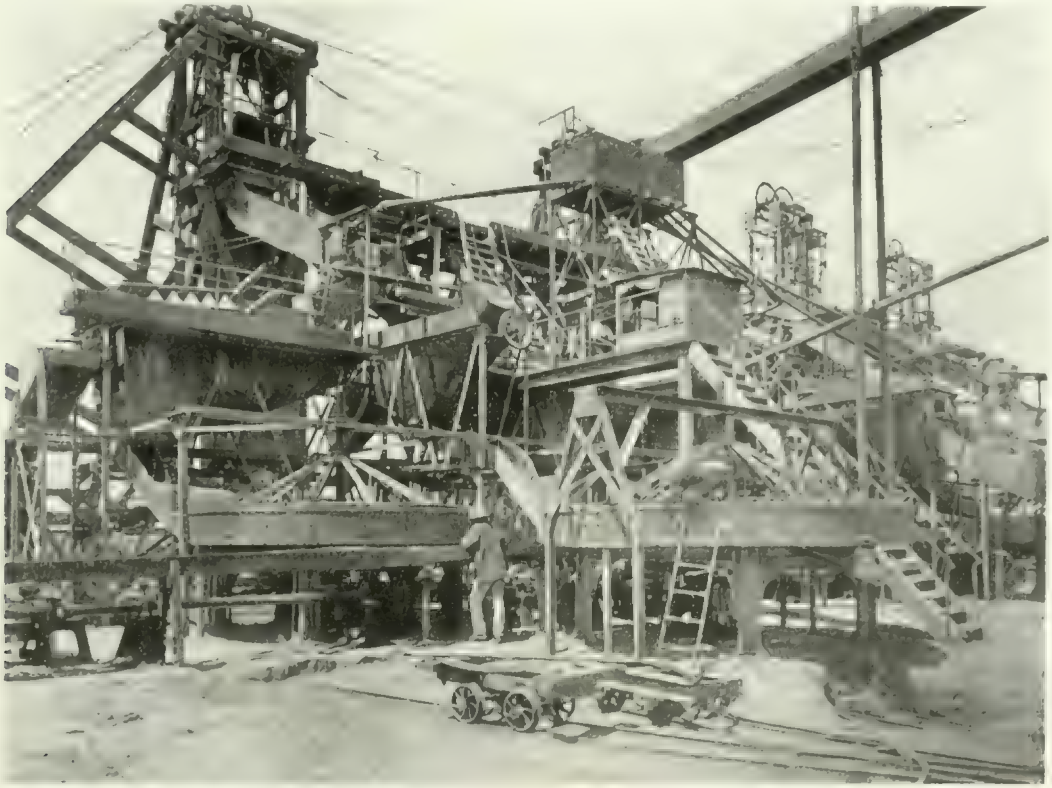
[illegible] Messrs. David Joy and Son, Consulting Engineers, will, in future, be carried on under the name of David Joy and Cooper. Mr. Jasper E. Cooper, who left a well-known shipbuilding and engineering company some time back to take up [illegible] and will continue to manage the affairs of the new firm. It is intended as soon as possible to put several of the late Mr. David Joy's ideas into practical form and place other useful inventions upon the market.

Mr. G. E. Heyl-Dia, of Stretton, near Warrington, informs us that having resigned his office as Managing Director of the St. Helens Cable Company, Ltd., he intends in future to practice as a consulting electrical and chemical engineer, in connection especially with the erection of cable plant, and the designing of cable systems generally.

[illegible] Bradford, who recently purchased the works, business, [illegible] inform us that they have now removed from their [illegible] request that all inquiries, correspondence, etc., may be forwarded to them, addressed Thornbury Works, Bradford. It has already been found necessary to extend the premises at Thornbury, which are being equipped with modern machinery designed to further increase the company's output, and enable them to make quicker deliveries.

Engineering Standards.

[illegible] Trade Vote for the current financial year a grant of £3,000 in aid of the funds of the Engineering Standards Committee. The expenditure under the vote will be authorised by the Board of Trade on the recommendation of a committee of the Institution of Civil Engineers with a representative of the Board of Trade. In presenting the Navy Estimates to the House of Commons, Mr. Arnold-Forster stated that all Admiralty orders would in future be given in terms of the standardised dimensions.



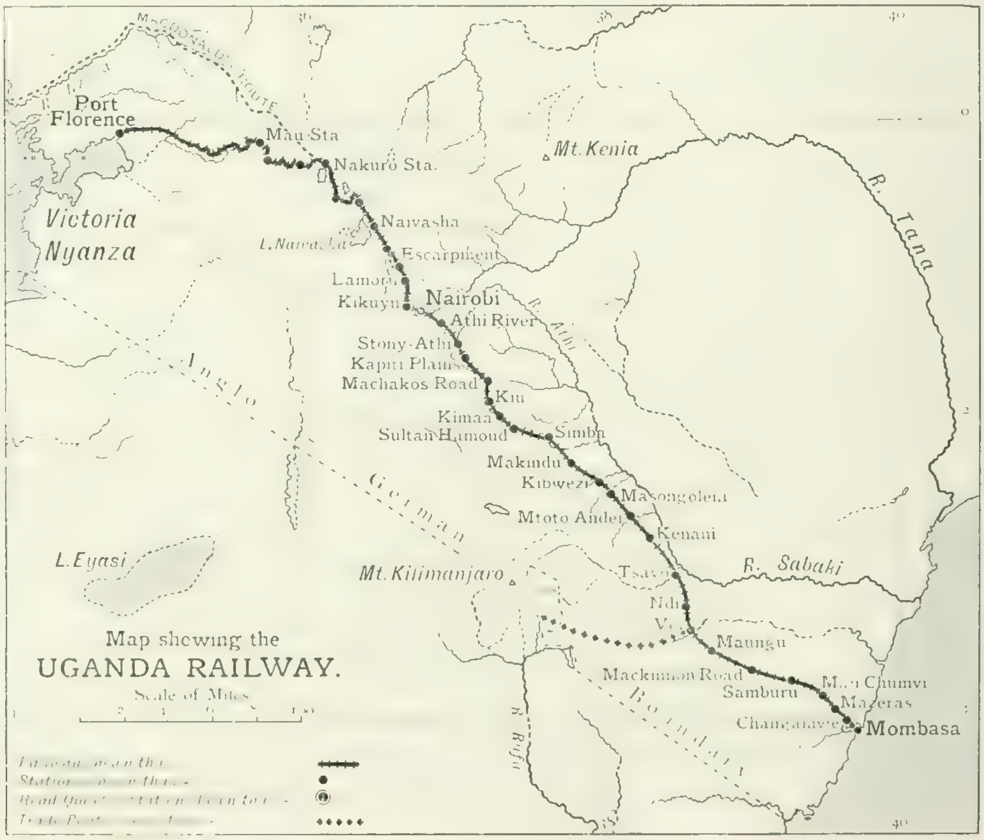
A CLOSER VIEW OF THE WASHING PLANT, DE BEERS DIAMOND MINES.

The Uganda Railway.

Mr. Herbert Samuel, M.P., in the course of a lecture to the Society of Arts on "The Uganda of To-Day," pointed out that the Protectorate may now be reached by rail and by steamer in less than four weeks' travelling from London. One of the causes of the wonderful development of the country is the Uganda Railway, which has shortened the journey from the coast at Mombosa to the capital of Uganda to five days instead of three months, and has cheapened the cost of the carriage of goods in proportion.

"This line is a Uganda railway in name, but in name only. It does not enter, and it is not designed to enter, the Uganda Protectorate. Its entire length lies within the boundaries of the Protectorate of British East Africa. Starting from the fine harbour of Mombasa, on the East African coast, it runs in a west-north-westerly direction for 580 miles, until it reaches the shore of the Victoria Nyanza at a spot in the neighbourhood of Kisumu, which now bears the name of Port Florence. From this place it is a two-days' voyage across the lake to Entebbe in the centre of the Uganda shore."

Mr. Samuel referred to the cost of construction as undoubtedly excessive. It was estimated to cost under two millions, yet Parliament has been called upon to vote nearly six millions to complete it. It is true that there have been many difficulties which were unforeseen by the framers of the original estimate; engineering difficulties, difficulties in obtaining labour, difficulties in the supply of water, and an increase in the cost of coal. But the fact remains, when full allowance has been made for these, that the claims of economy have been regarded somewhat lightly by the Foreign Office Committee and by the engineers who have been charged with the construction of this line. "I state this not as an opinion founded on my own observation, but I was fortunate in having opportunities for discussing the question with a number of Europeans in East Africa and Uganda; and the universal opinion of those on the spot is that there has been frequent extravagance in the methods of construction, that unnecessary works have been undertaken, that many mistakes have been made, that there has been much laxity of financial control in matters of detail. From none of those whose views I ascertained did I hear a contrary opinion. But no one who is acquainted with the circumstances can in fairness fail to bear testimony that, open as are the constructors of the railway to criticism on this ground, they are nevertheless entitled to no small measure of gratitude from the country for the successful completion of this great national undertaking, carried out in a country previously almost unexplored, and accomplished in defiance of many formidable obstacles."



By kind permission of the Society of Arts.

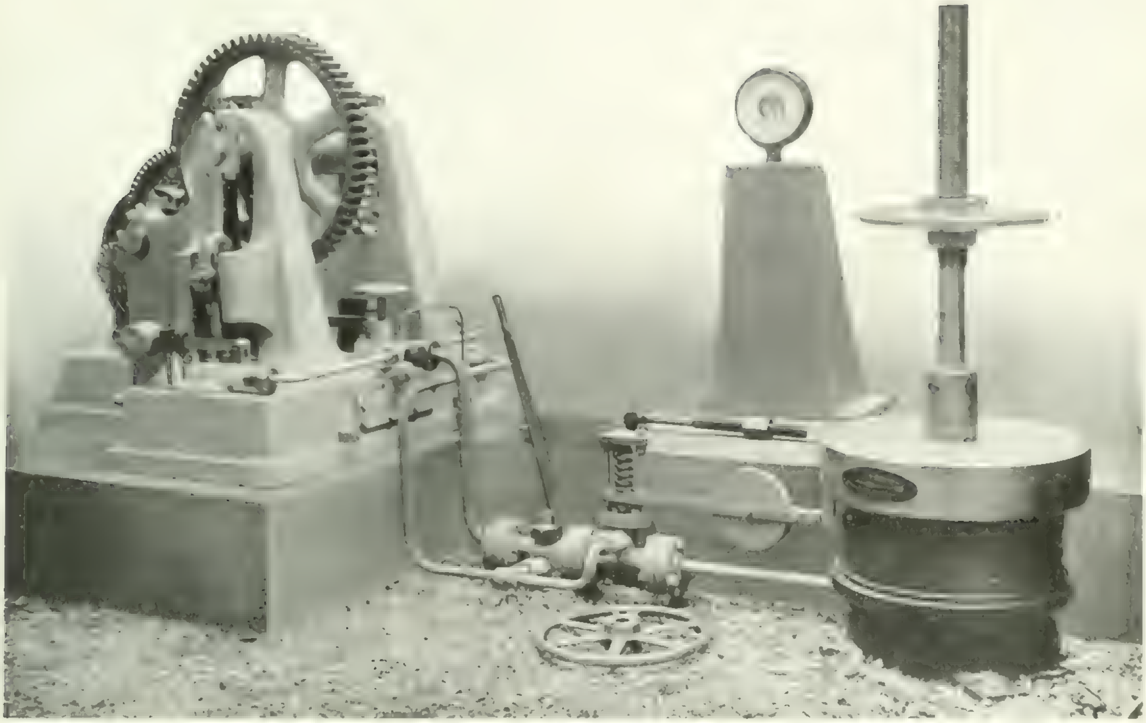


FIG. 1. WEST'S PATENT 200-TON COMMUTATOR PRESS.

A New Line to Portsmouth.

The London and South-Western Railway Company are about to open a new and more direct route to Portsmouth. This route has been made by the construction of what is known as the Meon Valley line, which has been designed to form portion of a main through line of railway from London *viâ* Aldershot, Farnham, and Alton to Gosport, Portsmouth, Stokes Bay (for the Isle of Wight), and also to Southampton *viâ* Netley. It is 22¼ miles long and follows from its beginning near Alton throughout almost its entire length the course of the old London and Gosport turnpike road. The new line opens by a junction with the South-Western Company's Farnham, Alton, and Winchester branch line about a mile west of Alton Station, and joins the South-Western Company's Eastleigh and Portsmouth branch line at Knowle, about two miles north of Fareham. The earthwork and permanent way for the present are single, but a double line can be added to the railway merely by widening some of the cuttings and embankments and without pulling down and reconstructing any of the bridges or other works. The ruling gradient is one in 100, and all the curves are suitable for running at express speed; while the platforms at the stations have been made long enough to accommodate main line trains. There are two tunnels on the route, one at Privett, 1,065 yards long, and another at West Meon, 539 yards long. A viaduct carries the railway over the River Meon, at West Meon. It is 62 ft. above the ground and is made in four arches, each of 56 ft. span, and supported on steel piers resting on concrete foundations. Messrs. R. T. Relf and Sons, of Plymouth, were the contractors, and the line has taken about four years to construct.

West's Patent 200-ton Commutator Press.

Although electricity has during recent years competed successfully with hydraulic power in certain applications, it is a noteworthy fact that high-pressure hydraulic plant is used to a considerable extent in the factories of electrical manufacturing firms.

On this and the following page we illustrate a special type of hydraulic press designed for commutator and armature construction. Fig. 1 is a general view of the press with pump, valves, etc.; figs. 2 and 3 show the press as used for assembling commutators.

One of the most striking features of the press itself is the absence of the usual press head and columns, which are replaced by a single central bolt and nut, which makes a very compact arrangement, and is obviously most get-at-able. The press consists of a fixed differential ram, which rests on a cast-iron baseplate and a rising cylinder, the end of which forms the press table. Into the end of the smaller portion of the forged steel ram is screwed a bolt made of high-tenacity nickel steel (Messrs. Chas. Cammell and Co.'s). By using this grade of steel it is possible to reduce the diameter of the bolt and still retain the strength of a larger mild steel bolt.

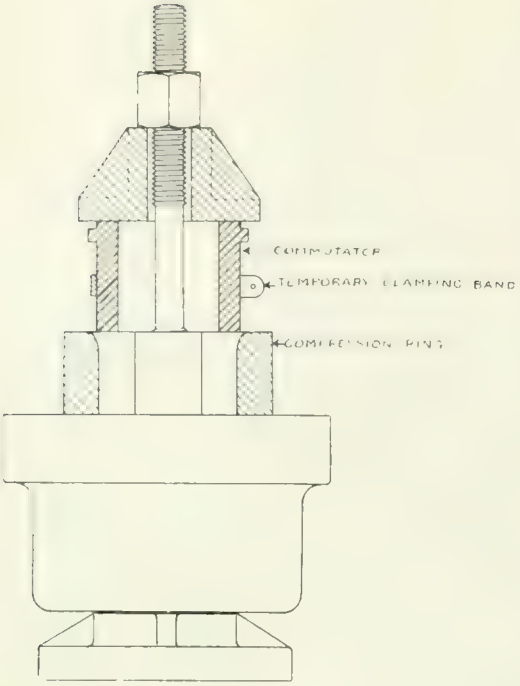


FIG. 2.

The type of press under notice is suitable for (1) assembling commutators, (2) tightening the end plates of commutators, and (3) pressing armature discs on to their spiders. The method of using the press for assembling commutators is of sufficient interest as to be worth a brief description, which will be clear after an inspection of figs. 2 and 3. The copper bars and mica are loosely held together by a hinged temporary clamping band, and the commutator placed with its lower end just entering the bell-mouthed neck of a compression ring which is tapered for a portion of its depth and parallel for the remainder; the nut on the central bolt is run down, and pressure is admitted into the annular space in the cylinder, which causes the latter to rise and draw the commutator into the ring. The commutator is then machined within the ring and brought back to the press to have the ends pressed on and the bolts or nuts tightened, after which it is drawn out of the ring by packing the ring up from the face of table.

The pump employed is of very strong construction, and has the crank-shaft journals placed underneath the arches of the standards, so as to remove all strain from the studs of bearing caps; there are two plungers, one 1 in. in diameter which works to 4,500 lb. per square inch, and one 2 in. diameter which automatically cuts out when the pressure reaches 900 lb. square inch. The pump is driven through cut spur wheels and raw hide pinions by one of Messrs. Vickers, Sons, and Maxims' 5-b.h.p. slow-speed motors, and the starting rheostat is intended to be placed on the front panel of the small standard carrying the pressure gauge.

The makers of these presses, the West Hydraulic Engineering Company, of 23, College Hill, London, E. C. inform us that they have sold a large number to work from belt driven or hand pumps, intensifiers, existing high pressure mains, and, in one case, from a miniature direct steam driver.

The Iron and Steel Institute.

An exceptionally interesting programme has been arranged for the annual meeting of the Iron and Steel Institute to be held at Westminster on May 7th and 8th. Mr. Andrew Carnegie's inaugural address will deal with the great organisations of capital and labour in the world, more particularly in relation to American industrial problems. Mr. Carnegie will also present Sir James Kitson, Bart., M.P., with the Bessemer gold medal for his services to the iron and steel industries of this country. The work of the research scholars endowed by Mr. Carnegie will also be submitted. Some notable papers will be read. Mr. Talbot, of Leeds, will give the results obtained by making steel from a 200-ton furnace by a continuous process; Mr. Keller, of Paris, will describe the successful manufacture of steel in the electric furnace; and C. von Schwarz, of Liége, will show how blast furnace slag can be made into Portland cement; Mr. C. Mercader, of the Carnegie Works at Pittsburg, will for the first time in public describe the plant for manufacturing hollow pressed axles for railroads. The Prime Minister, the United States Ambassador, and several members of the present and past Governments, have accepted invitations to be present at the annual dinner.

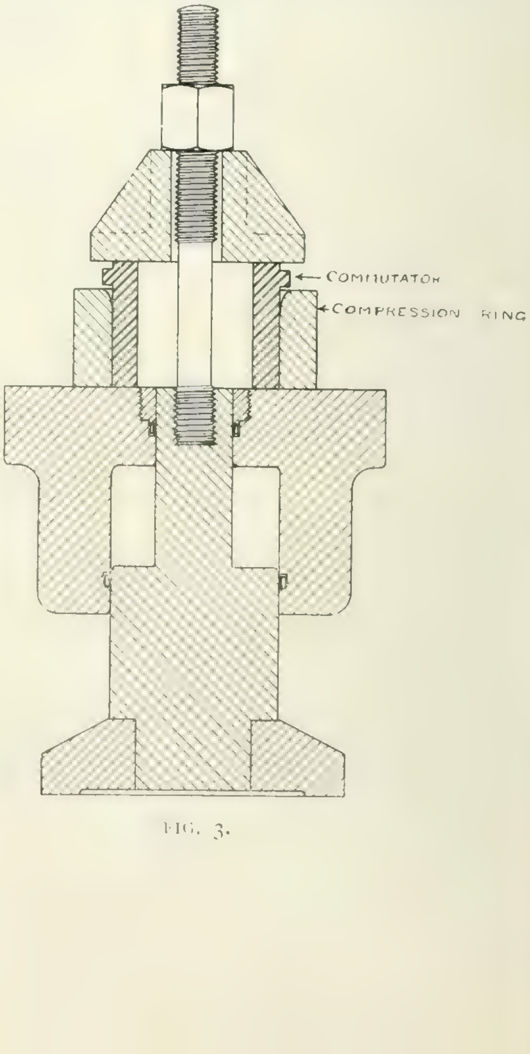


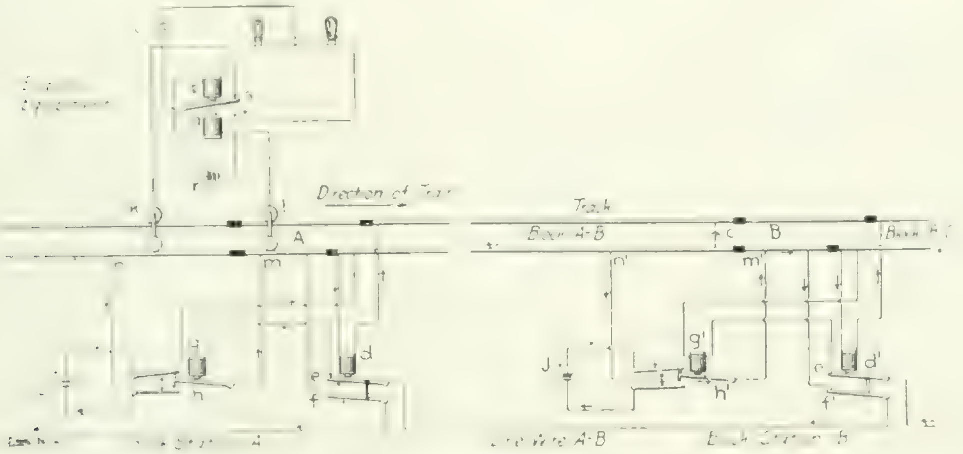
FIG. 3.

Notes and News.

The Miller Railway Signal System.

[illegible] introduced into this country by the British Miller Signal Syndicate, of 9 and 11, Fenchurch Avenue, differs from other automatic signals in respect to the important fact that the signals are given directly *in the engine cab.* Two small electric lamps, one coloured red, the other white, are mounted in the cab within easy view of the engineer; when the train enters a block, one of these [illegible] of the next block is reached. If the track is clear for two blocks ahead, that is, if there is no train or part of a train in either of the two blocks ahead, then the white lamp lights up when the train reaches a block point; if either of the two blocks is occupied, the red lamp lights up. To comply with British Board of Trade regulations, an outside electric indicator is also fixed at certain crucial positions on the track. This indicator gives a white, green, or red light: its chief use being to perform the functions of a "home signal," while the lights on the engine form the "distant signal." When the red light is given on the engine, the driver slowly reduces his speed and brings his train under control, but, if upon reaching the outside indicator, he finds the "red" there also, he must make a dead stop.

A provision against failure of electric light in the engine-cab is made in the shape of a small semaphore arm inside the cab instrument. This little arm rises at danger and falls at safety, and acts concurrently with, yet independently of, the two little lamps. These are carried from a central base-piece, and are surrounded by protecting glass cylinders; spring supports are provided for the ends of the bulbs. Only one of the [illegible] source of electricity, on the engine, and is switched on to one or the other lamp by an electro-magnet reversing switch actuated from the track circuit. The lamps, battery and reversing switch constitute the entire train-carried portion of the signal equipment. The remainder of the apparatus is fixed, and may be called the track equipment. It is presupposed that the track is divided into blocks of convenient length (½ mile to one mile), and that at each block point a portion of the track a few rail lengths in extent, is insulated from the rest of the track by insulating rail joints. The two rails in each block are utilised to form a track circuit for detecting the presence of a train in the block; a battery is placed across them, and when a train or car is in the block this battery is short-circuited through the wheels and axles.



GENERAL ARRANGEMENT OF INSTRUMENTS AND CIRCUITS IN THE MILLER SIGNAL SYSTEM.

The track equipment for the Miller signal comprises a relay instrument at each block station, provided with a battery and a line wire connecting the different block stations. The function of the relay instrument is to connect the battery to the rail in such a manner as to give the proper signal to the engine when the latter crosses the insulating joint at the rear end of the intermediate track section.

The system is capable of great adaptability, but the accompanying drawing will serve to illustrate its simplest form.

The arrangement of the apparatus is shown in detail above, two consecutive block stations, A and B, being shown. The instruments at A and B are precisely similar. A magnet (d) has its coil connected across the rails at the rear end of the block, and when that block is clear the current from the track circuit energises the magnet. The magnet has two armature contacts, one of these (f) communicates with the preceding block station through line wire and rail, by way of (m), (h) and (n); the other contact (e) communicates with the succeeding block station, by way of line wire and rail, through the coils of a second magnet (g). This latter has an armature (h) which acts as a reversing switch for battery (j), and connects this battery with the points (n) and (m) of the rail, on opposite sides of an insulated joint. When armature (h) is attracted, as it is represented in fig. 1, then the current from (j) tends to flow in the rail from point (m) to point (n); when (h) is dropped, the current tends to flow from point (n) to point (m).

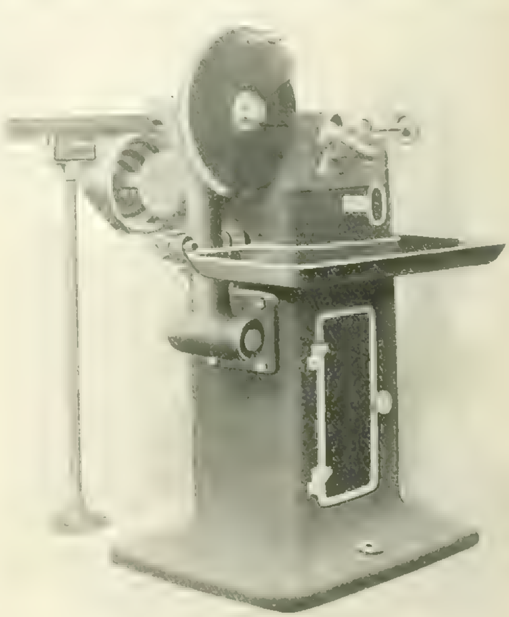
The operation of the relay instrument and its electric circuits may now be readily followed out. When the track A-B is clear, then magnet (d) is energised by track battery (c) and attracts its armature. Similarly, when block B-C is clear, magnet (d′) at B attracts its armature. We have then an electric circuit as shown, from battery (j′) at B, through (h′) and wire (m′), through lever (f′) back to instrument A, energising magnet (g), and back through rail A-B. Armature (h) is then attracted, and an electric pressure is set up from point (m) to point (n). When either A-B or B-C is occupied, then the circuit through the coils of (g) is broken, at (e) or at (f′), respectively, and armature (h) drops, so that battery (j) tends to send its current from (n) to (m) through the rail. This pressure between (n) and (m) is utilised by the locomotive equipment to give a signal in the engine cab when the engine crosses the joint between (n) and (m).

The engine equipment may have several different forms, one of which is shown above the track in figure. One axle each of engine and tender (k) and (l), are insulated from each other, and are connected through the coils of two magnets, (p) and (q). The armature which plays between the poles of these magnets is adapted to make contact at (s) or at (t), completing the circuit of a battery (u) through the white lamp or the red lamp, respectively. When the engine crosses the insulating joint above referred to, the pressure between (n) and (m) causes a current to flow through the coils of magnets (p) and (q), and the direction of the current determines whether the armature is attracted up or down, to light the white or the red lamp. When the current flows from (k) to (l), then the armature is attracted downward, lighting the red lamp, and indicating that either block A-B or block B-C is occupied. When both blocks are clear the battery (j) sends current from (m) to (n) or by way of axle (l) to (k), so that the armature is attracted upward and the white lamp lights up.

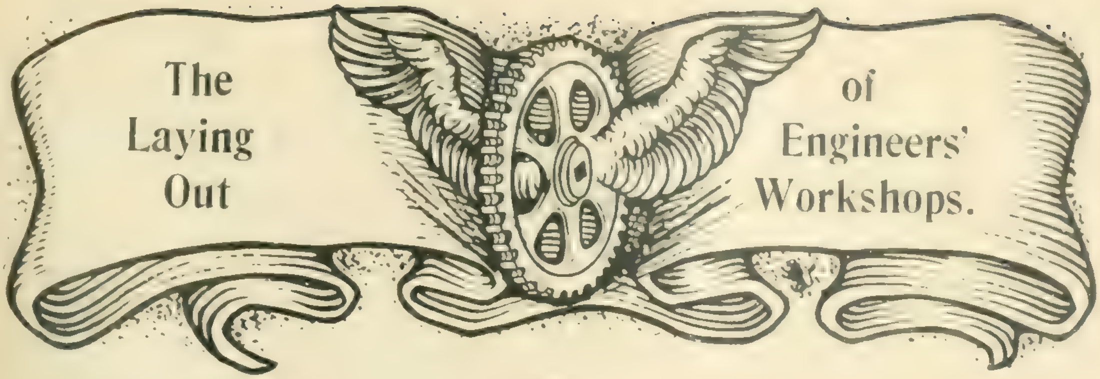
It will be noticed that a small battery (r) is arranged on the engine for a local circuit through the coil of magnet (q), in such a way that no polarised armature is required, while at the same time the battery (r) acts to hold the armature in place, either up or down, while passing through the block. When an insulated joint is reached the circuit of (r) through magnet (p), by way of the rail back to (l), is broken, and magnet (q) being still energised, the armature drops and lights the red lamp. Thus the engine always gets a red signal the moment it passes an insulating joint, unless at the same moment the "Clear" impulse from the track relay operates to keep the white lamp alight. In order to avoid this action while crossing the insulating rail joint at the rear end of block A-B, this joint in the two rails is staggered longitudinally a distance of half a rail-length, or at least a distance greater than the interval between axles (k) and (l).

New Automatic Circular Sawing Machine.

For cutting up brass and copper tubes, bars and sections, a new automatic circular sawing machine is being made by Messrs. Edward G. Herbert, Ltd., of Manchester. The machine is entirely self-acting, so that all the attendant has to do is to place the bars between the feed rollers. The speed of cutting can be varied from 6 to 60 cuts per minute, according to the character of the work. A bar is placed between the feed rollers, and the machine being started, alternately feeds the bar forward and cuts it off. When the bar is entirely cut up, the repetition mechanism throws itself out of gear until another bar is put in. The saw is provided with a quick return motion. One movement of a handle stops the repetition mechanism at any time, and converts the machine into an ordinary saw bench, when single cuts can be made by hand. The machine cuts sections of any shape and any size up to 2 in. by 2 in., and there is no limit to the length of the pieces which can be cut off. The saw, the gearing, and all the working parts are enclosed and guarded.



AUTOMATIC CIRCULAR SAWING MACHINE.



The Laying Out of Engineers' Workshops.

BY

JOSEPH HORNER.

III.

The present article deals with the ground plans of works, and after setting forth his theories thereon, the author describes the plans followed in laying out a number of typical establishments. To a great extent the illustrations tell their own story. The previous articles of the series appeared in the March and April issues.—ED.

THE GENERAL PROBLEM STATED.

IN arranging to utilise a piece of ground to the best advantage for the laying out of works consideration must first be given to the separate floor areas required for the different shops. Then follows their location, the problems of area and location often conflicting, because the area required is not always available in the location that happens to be the most suitable.

Location is determined by five things: The class of work to be done, and its volume; the area required, and that which is available; the relation to means of transit; the relations of departments; and allowance for expansion. And thus it happens that the best place for a shop is not always that which would be selected were no other shops to be considered.

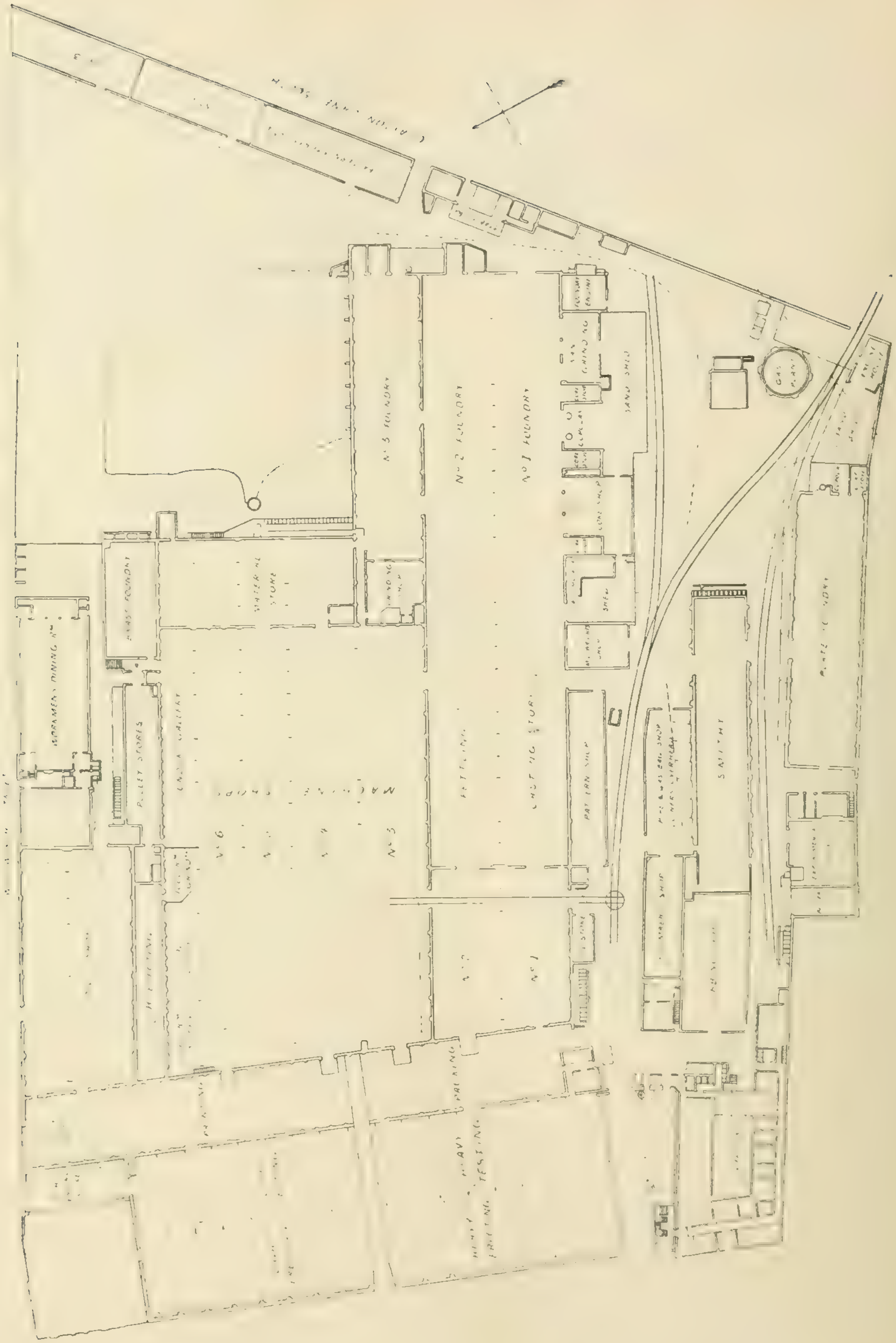
THE CLASS OF WORK TO BE DONE, AND ITS VOLUME.

This generally determines whether a shop shall be placed on the ground, on a floor, or in a gallery. The shops which must always be on the ground are the smithy, foundry, boiler and plating, and heavy machine, and erecting shops. There can be no alternative with regard to these. Those which may alternatively be on upper floors, or in galleries are the offices, the pattern shop and its stores, the light machine shops and turneries, whitesmiths' or coppersmiths' shops, light fitting shops, light electrical, and testing departments. Offices are most conveniently located in storied buildings. On a piece of ground of limited area it is best to take advantage of this distinction, and locate the lighter industries on floors, or in galleries, and so leave a margin of ground area for the future growth of the heavy departments, rather than occupy all the area at once with shops, some of which may well go on floors. But if, on the other hand, there is ample area for present and prospective requirements it is generally preferable to avoid floors altogether, and allot side bays or wings to the lighter industries, flanking the heavy shops and in free communication with them. An exception may be made of the offices, and in some instances also of light machines and lathes which can very well go on galleries round the main shops.

THE AREA REQUIRED, AND THAT WHICH IS AVAILABLE.

The dimensions of this can only be obtained by careful calculations, based on the output of each separate shop. There is no rule of any kind by which it can be determined. Thus, one establishment having an output reckoned by tonnage will require very different shop areas from another of about equal output but engaged on a different class of work.

In a foundry, the number of sets of work required in a week will appropriate so many moulding boxes of certain sizes, and these will occupy an easily calculated amount of floor area. Allowance must be made for boxes when laid open, and not when closed for pouring. Room must be allowed for unhampered movements of the men between the boxes, for fettling areas, stoves, pits, etc. Besides these, the locations and sizes of cupolas, room for ladles, sands, and other stores must



GROUND PLAN. "OTTO" GAS ENGINE WORKS OF MESSRS. CROSSLEY BROS., LTD., OPENSHAW, NEAR MANCHESTER.

The Laying Out of Engineers' Workshops.

be provided for on as liberal a basis as the means available will permit of. In machine shops the floor areas of the machines to be laid down will be taken, the widths of gangways allowed between them to permit of proper handling of work, the areas for stands and racks, main gangways, and so on. In boiler shops, platers' sheds, and smithies the areas must be reckoned on an ample base for the maximum sizes of work that have to occupy the floors at one time. Here the floor spaces wanted for machines and forges form a smaller proportion of the total than they do in the machine shops. Every contingency that can arise in each shop must be thought over, and then when all is done, the judgment of the firm, or of their adviser has to decide how much each separate shop shall exceed the calculated areas, in view of the probable growth of business during a reasonable term of years. Often the error is made of underestimating this, and sometimes no room is left available for extension except in an upward direction.

THE RELATION TO MEANS OF TRANSIT.

In regard to this matter the principal point to emphasise is that the heaviest departments should be nearest to the railway siding, canal wharf, or roadway, whence materials are to be taken in, and from which work is to be despatched. The foundry, the boiler, and plating shops require the heaviest consignments of raw material, the heaviest deliveries being made from these, and from the heavy machine shops and erecting shops. If there are two or more agencies for transit available, then one may offer better facilities than the other, being either cheaper, or more directly connected with localities whence stores are obtained, or with ports of shipment. Where a very complete system of tracks is laid down, the aforesaid arrangement is of less importance than it would be in the absence of such a system, but as a rule the heavy shops should be laid out nearest the sidings or wharves. The locations of the pattern shop, the smithy, the brass foundry, the offices, are matters of secondary moment.

THE RELATIONS OF DEPARTMENTS.

The general rule must often be modified however by the next condition—that all departments should be mutually related. This means not merely that they shall be grouped in such a way that work in preparatory stages shall be always converging towards the secondary and finishing departments, but also that the means of communication between the several related departments shall be such as to lessen, as far as possible, the employment of human labour. This, however, applies more especially to massive work. Heavy work ought not to be allowed to return over its first tracks, that is, it should not be taken to one end of a shop, and then back again to make its exit by the door at which it entered, and so take a circuitous route to the next department. Labourers should neither have to cart it about, nor run it about on the floors and yard, if tram-lines can be made available. But here, too, modifying influences may exist. Rapid transit by cranes or tracks may be available, and work may thus be taken back on its tracks with less loss than would be involved in a different arrangement of shops. It is clearly a question of cheapness and quickness of transport by cranes or locomotives.

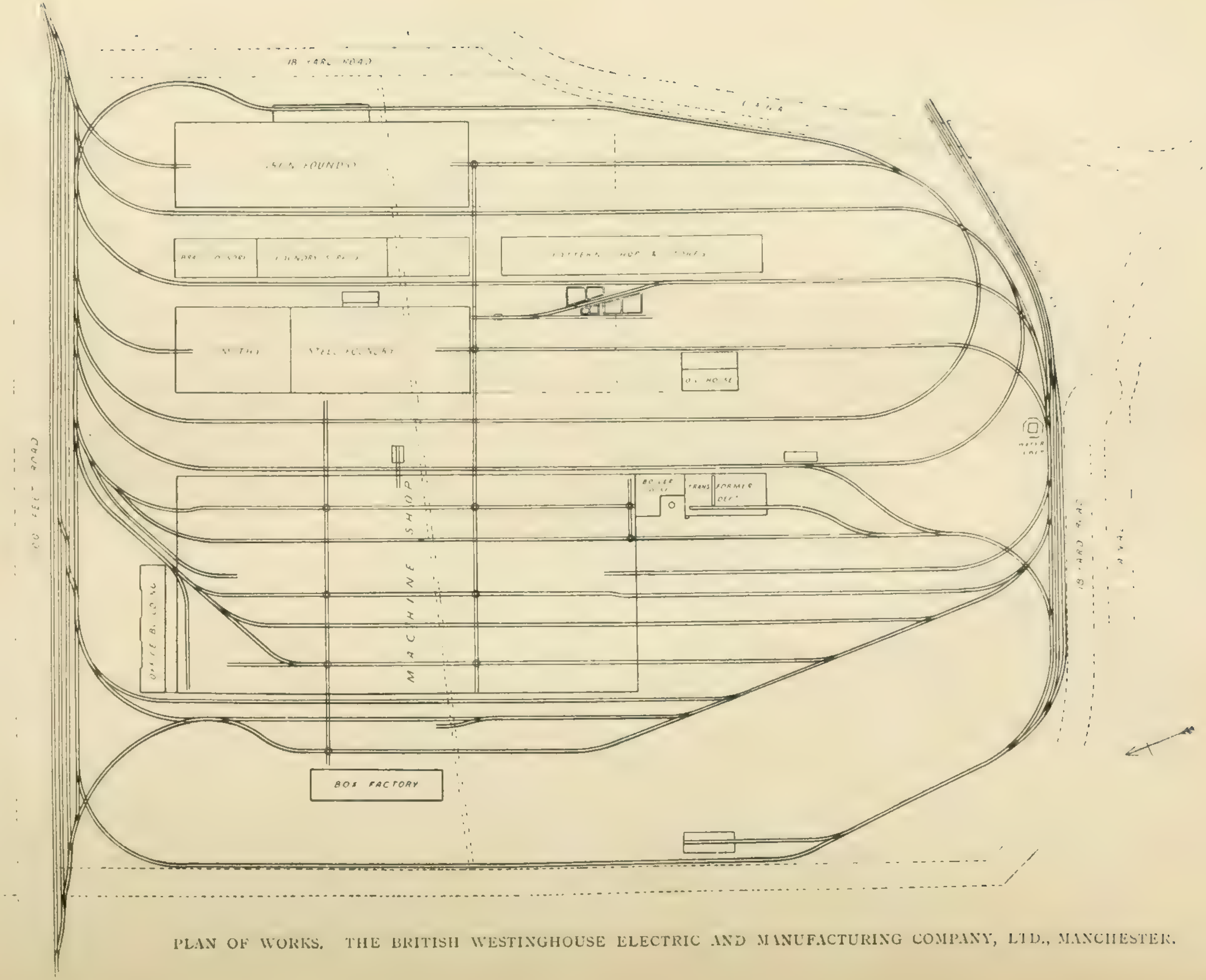
ALLOWANCE FOR EXPANSION.

It almost goes without saying that in all new works allowance should be provided for expansion. The question will of course be considered in putting up new buildings. But beyond this some waste land ought to be retained when possible for the erection of future buildings should such become necessary in say, five, ten, or fifteen years' time. Few firms can forecast their potentialities of expansion, and a wise policy should be prepared to meet eventualities. New manufactures spring up in very short periods, as witness the electrical industry, or specially the electric tramway industry. Even if the whole of the ground is never required, such an area is always valuable for the temporary storage of iron and timber, for the erection of massive work, especially cranes, bridge, and similar plated work; while its value as an investment to let or sell increases with the lapse of time. It has often been an occasion of regret to firms that they have allowed opportunities for the acquisition of ground to slip through their fingers, and have afterwards been obliged to purchase at an enhanced price, or not at all. The failure to secure sufficient land at an early period has been the reason for the division, and also for the migration of firms. These latter prefer to make a fresh start away from the town, on plenty of land, instead of remaining in a crowded district, or building separate detached works, with their many disadvantages due to separation from the other shops.

LARGE AND SMALL WORKS.

The problems to be attacked are not alike when commencing to plan out large works on the one hand, or small ones on the other. The shops of greatest magnitude must be laid out without much regard to those of lesser magnitude, but in small works all the shops must be considered of nearly equal importance. This will be clearer if we take a typical example or two.

In large firms the biggest and most important shops are the foundry, smithy, plating and boiler-making departments, the machine shop and turnery, fitting and erecting shops, and the yard. But many small works have no foundry, no plating or boiler-making shops. Many works of fair size are destitute of the latter, and comprise chiefly foundry, smithy, machine shop and turnery, fitting and erecting shops, and yard. The other small departments need not be enumerated, but it is always possible to find room for these in a scheme which provided first for the major ones named. Again, in firms where all these shops are represented, it does not always happen that they exist in normal proportions. In normal works the foundry and machine shops are the principal departments, and are much larger than any others. But in special industries the works may be a congeries of numerous small shops only. Or, one or two



PLAN OF WORKS. THE BRITISH WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY, LTD., MANCHESTER.

[illegible] plate moulding, or die forging, or brass finishing. So [illegible] of castings is the principal department; that of others where the machine shop and turnery constitute nearly the whole of the works, castings being procured out; and others in which stamping shops form the central and chief part of the works. Some, again, are boiler- [illegible] work, and plated work occupy the entire area, with a few small, but necessary, subsidiary shops. All these involve problems different from those which arise in the normal or ordinary engineers' works that contain all the departments noted in the previous article of this series.

NORMAL WORKS.

[illegible] a firm in which all the departments occur in what we may term normal, or commonly balanced proportions, and in which ample ground area is available, the best arrangement of the shops is that wholly on ground floors, the offices only being storied buildings. Legitimate exceptions occur when products of the firms consist altogether, or mainly of small articles, though even in this case tall buildings have no advantages over ground areas, excepting that of occupying less ground, and costing less for foundations and roofs. The mere compactness of the arrangement is of little or no advantage, and a great objection to stories is the loss of light caused by the substitution of ceilings for a roof.

A combination of the two systems is, however, advantageous, when it is desired to reserve some vacant space for expansion. Stories can be utilised for pattern making, and pattern stores, for light carpentry, light machines, and fitting and assembling, and also for coppersmiths, and white-smiths' work. But these ought not to be placed over the foundry, or boiler shop, or smithy, or even over the heavy turnery and machine shops, where they would block the light from the shops below. They should be in separate buildings.

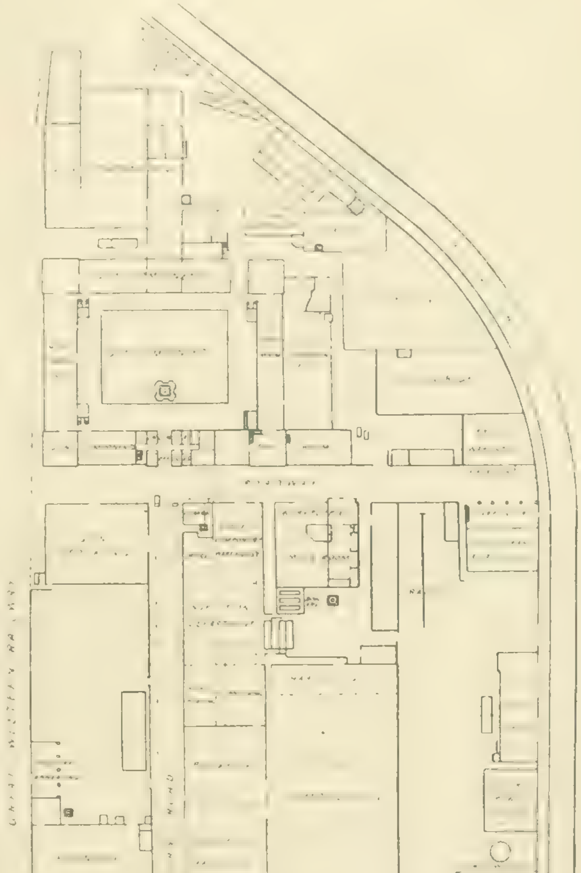
THE LAY OF THE MAIN SHOPS.

The lay of the main shops is the paramount consideration. They must be determined with regard to their requirements, to which the lesser ones must, if need be, be subservient. The best designs in existence can be broadly divided into three groups, that in which the shops run in parallel lines, that in which they form three sides of a rectangle enclosing a yard, which may, or may not, be partly occupied by other shops, and that in which isolated blocks of buildings are grouped or scattered over the areas. We will consider these separately.

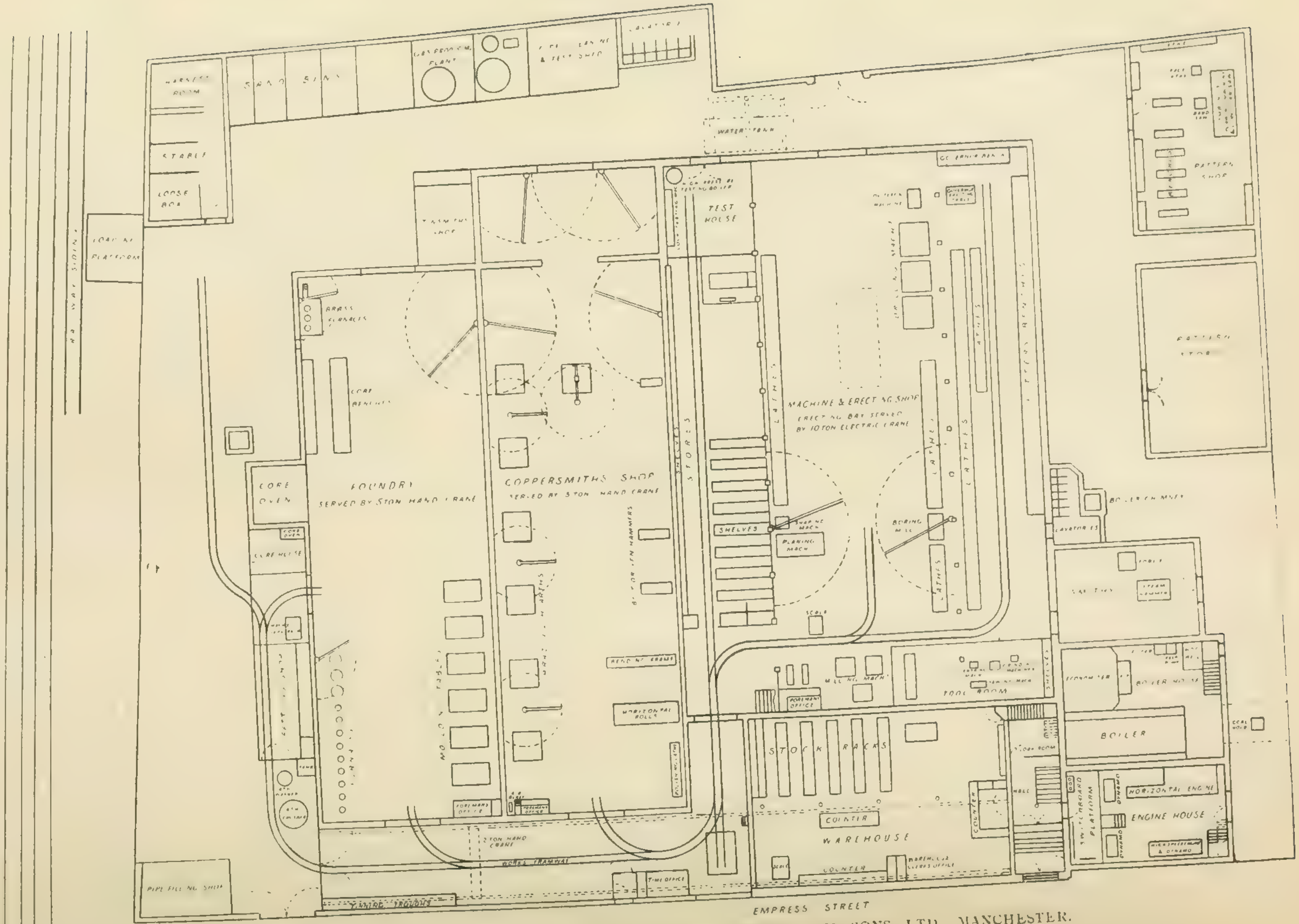
SHOPS RUNNING IN PARALLEL LINES.

These represent the most approved designs of what we may term the normal type of engineers' works; but in order to carry out this ideal properly, a nearly rectangular piece of ground is necessary. If a tapering or a wedge-shaped piece of ground has to be utilised, [illegible] and others lie at right angles with these at the narrower end. To this there is no objection provided the due relations of the shops and their means of inter-communication, already noted, are provided for.

The advantages of running shops in parallel lines are these: A line of rails can be brought along in front of one, or of both ends of the buildings, and a turntable be located opposite each doorway for running of stuff into and out of each. Ground is economised, since instead of having narrow strips of yard between



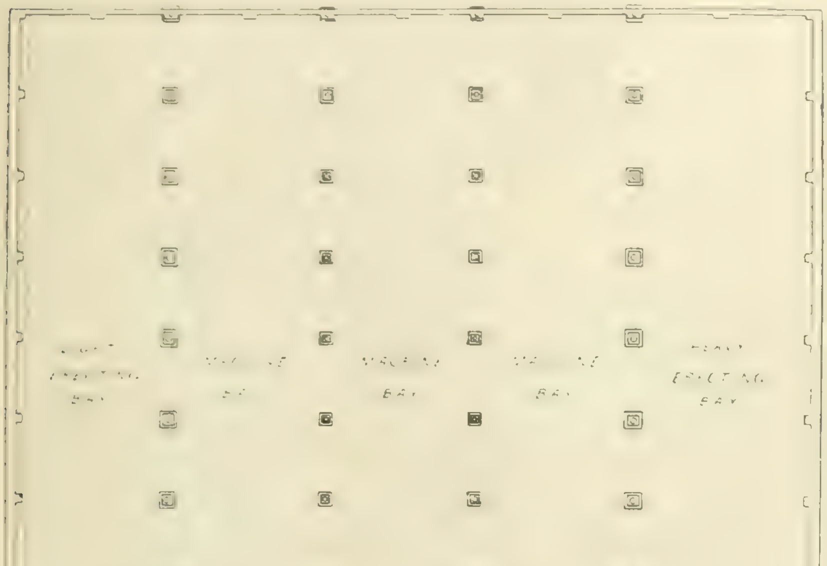
PLAN OF WORKS. BIRMINGHAM SMALL ARMS CO.



GROUND PLAN OF THE EMPRESS WORKS. MESSRS. ISAAC STOREY AND SONS, LTD., MANCHESTER.

shops which are of little value, the yard room available is thrown into a large area or areas common to all the shops. Further, the yards at each end can when the nature of the work done renders it desirable, be served by out-door cranes, either of Goliath, or traveller type, or of portable balance types, that will supplement the trolleys or else take their place. The arrangement in line, moreover, permits of uniformity of design in regard to dimensions, the lighting, the cranes, and so forth. There is no reason why different main designs should be adopted say for the foundry, boiler shop, plating shop, smithy, machine shop, turnery, and erecting shops. The only differences that are essential occur in the dimensions, and their internal arrangements [illegible]

With regard to light, it is better to have the shops arranged in such a way that the roofs all lie in one direction. Many prefer the saw tooth type and north light, but the majority do not carry utilitarianism so far. But the question of light will be considered in another article. With regard to cranes the long shops of uniform section throughout are necessary if the economies of overhead travelling cranes, or of overhead tracks for hoists are to be taken full advantage of. And, as a broad statement, it is better from every point of view to have shops of similar sections running in parallel lines, than to adopt a heterogeneous arrangement.



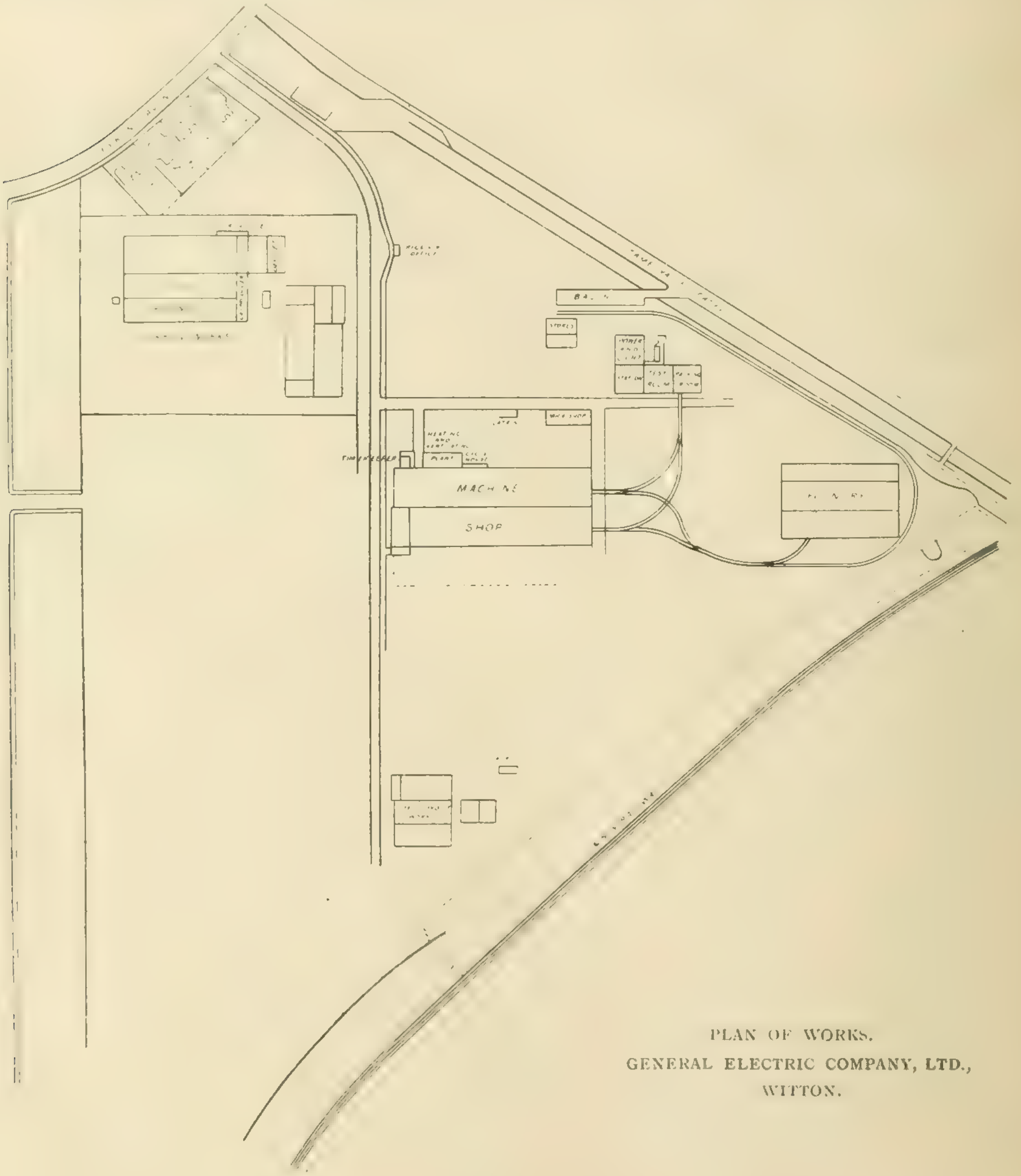
PLAN OF MESSRS. C. REDMAN AND SONS' WORKS, HALIFAX.

SHOPS THAT FORM THREE SIDES OF A RECTANGLE ENCLOSING A YARD, WHICH MAY OR MAY NOT BE PARTLY OCCUPIED BY OTHER SHOPS.

This design is usually associated with the storied buildings. Here the chief advantage is that a yard is enclosed into which material is brought, and from which goods are delivered, and which may be utilised for the erection of work in the open, or under an open-sided shed. Here it may be painted and packed. The area can be served with rails, or a crane, or both. With regard to the internal arrangements of the floors in these, all the shops on a storey are, or should be, closely related. If the works are, say, a brass founders', the casting, and fettling will all be done in the basement. The lathes and machine tools should be on the first floor, and the fitting and finishing departments on the next. Inter-communication of floors is by means of stairs for men, and lifts for work, or trap doors. The best arrangement is that of iron stairs outside the building, facing the enclosed yard, for the use of the hands, and cranes outside for the materials, supplemented lifts within. This arrangement of shops is the only one possible for firms in crowded cities. And even in the suburbs it is well suited to the lighter engineering industries, as brass work of all kinds, light machine tools, motor and cycle works, pitch chains, small engines, small tools, and similar classes of work.

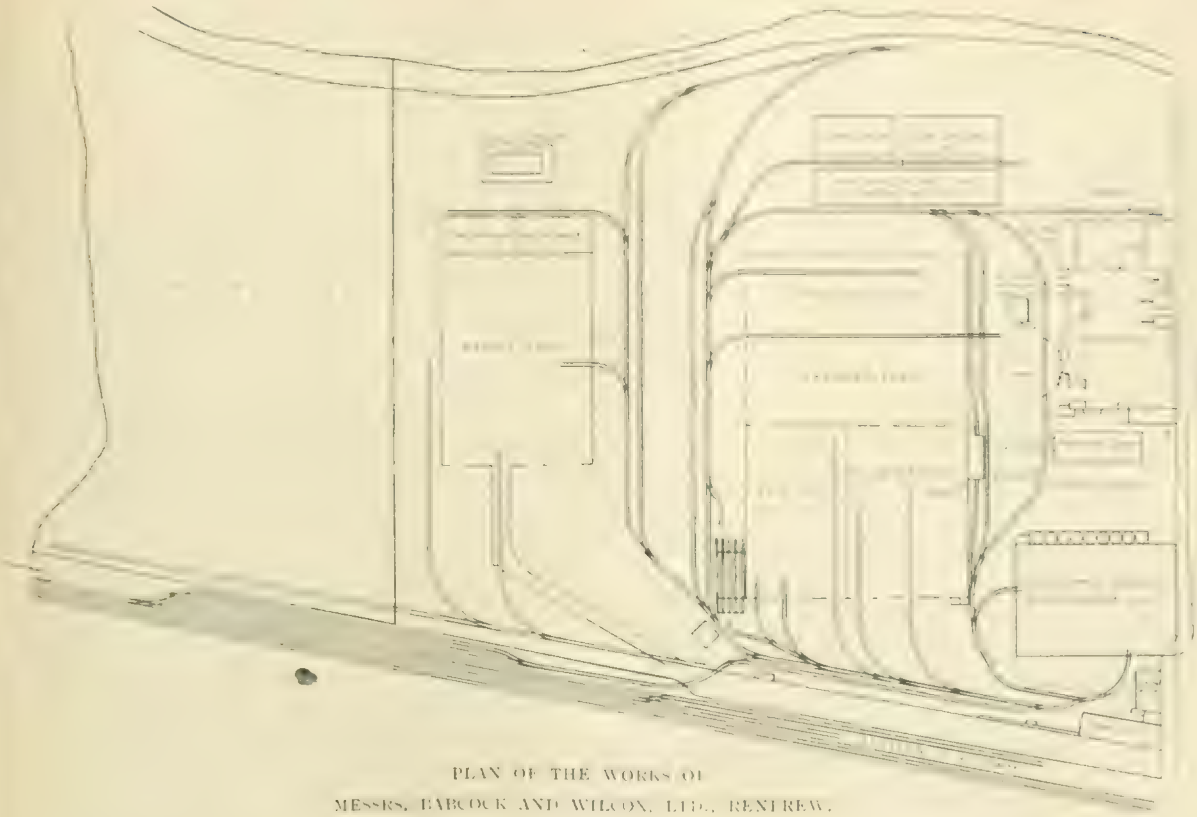
ISOLATED BLOCKS OF BUILDINGS WHICH ARE GROUPED OR SCATTERED OVER THE AREAS.

These include the largest number of the older engineers' works in existence, and they will always be in evidence because of the ever-growing need for expansion of businesses for which new buildings have to be provided. Another explanation exists in the addition of new departments, and more minute specialisation. Thus, a frequent addition to the works of old firms is a foundry. Many firms have developed a very big trade before deciding to build a foundry of their own. Sometimes it is a boiler or plating shop that is added, or a stamping shop, or a grinding department. In others it is an electrical shop, or the work of the machine shop and turnery becomes more differentiated. And thus many factories grow into a perfect maze of shops among which a stranger might easily get lost.



PLAN OF WORKS.
GENERAL ELECTRIC COMPANY, LTD.,
WITTON.

The Laying Out of Engineers' Workshops.



PLAN OF THE WORKS OF
MESSRS. BABCOCK AND WILCOX, LTD., RENFREW.

But some works are laid out in blocks of buildings from the first, even when the ground available would permit of running the shops in parallel lines. These are, however, often storied buildings, in which case, of course, parallel shops adjacent to each other would interfere with the lighting of the lower floors. In these cases, and in others where the isolated block system is adopted, the lay of the buildings should be either parallel, or at right angles with each other, never giving tapering patches of ground between shops. In these designs complete provision should always be made for free intercommunication between related shops, that is between shops through which the work has to pass in immediate succession.

THE OFFICES.

The position of the offices is an economical question only so far as it affects the movements of the principals, managers, and foremen. There is a constant passing to and fro of the heads of the works and the staff for consultations, visits, etc., and in a big works it is well to lessen distances as much as can be done. But much time is now saved by having every manager's and foreman's office in telephonic communication with the general offices, so that a walk is frequently saved. If the offices can be situated about centrally with the works front, without separating cognate departments, that is its best position. If not, a corner of the frontage is the next best.

THE GATES.

Small works generally have but one gate, large ones must have several if congestion is to be avoided. As all materials have to be booked and weighed in, and all finished work weighed and booked out, much clerical labour is involved. Big firms may be served by rail, canal, or river, and road, and each requires its own office and entrance gate. The men's entrance or entrances are often alongside one of the weigh offices, but this is not essential. In big works it is better to have more than one entrance to avoid crowding at meal times.

REMARKS ON TYPICAL WORKS.

The present article is illustrated with ground plans of works which are selected as being typical of diverse departments of engineering practice. They represent works that are very specialised on the one hand, and very comprehensive in character on the other. We have examples of very large establishments, and of those of medium dimensions, works situated on nearly rectangular plots of ground, and those on plots of less regular shape. A study of some of their leading arrangements will help to an intelligent grasp of the problems involved. The names of the various departments are printed so that ready references can be made.

THE OTTO GAS ENGINE WORKS.

The works of Messrs. Crossley Brothers, Ltd., at Openshaw near Manchester, afford an example of a highly specialised industry involving a large number of distinct shops. In these works (see page 126) about 1,500 hands are employed, and from them the weekly output of engines averages about 1,000 b.h.p. The works cover an area of about nine acres, of which seven acres are occupied by shops. As the firm makes its own castings, the foundries take up a large slice of the works. The main foundry comprises two bays, having free communication with each other, but having the light and heavy work separated. Besides these there is a third foundry separated from the main building by a wall, and having its own cupola, and core stoves. Away from these is another, also with its own cupola, and stove, and sand shed, specially equipped for plate moulding. The brass foundry again lies on the farther side of the machine shop.

Immediately adjacent to the iron foundry are the machine shop and turnery, in an immense rectangular building of four bays communicating with each other. The side farthest from the foundry is equipped with a tool room, a tool room smithy, an adjacent grinding room, and a gallery, which, though it looks small upon the plan, contains something like 170 small machine tools, 126 of these being lathes. These tools are driven by a 20-h.p. engine. On the side next the foundry lies the fettling shed, and the casting store, so that the work always moves without loss of time from foundry to machine shop and turnery.

There is an immense amount of machining to be done on gas engine work. The beds and cylinders require large tools, and a lot of room, which explains the reason for the vast extent of this department. The erecting is apportioned between separate shops, of which there are three—one for the heavy, one for the light, and the third for the smallest engines, of ½-h.p. only. The testing shops are bays under the same roof as the erecting ones.

The minor departments are the following: The pattern shop, and the millwrights' shop, close to the foundry. The pattern stores include three buildings right away from all shops, so that risks of fire are diminished. A rather large department is the material stores, where everything necessary for the machine and erecting shops is kept. The smithy lies between the main foundry and the plate-moulding shop. Adjacent to it lies the pipe and gas bag shop, the plumbers' shop, a general jobbing shop, and a small shop for experimental work. The painting shop is of large dimensions close to the testing departments. The offices are situated in one corner of the works, and do not therefore interfere with, or block shop arrangements. The gas plant is situated at the opposite corner, away from buildings. Two systems are in use, the Dowson and the Crossley, the latter to the extent of about 600 h.p. which the firm put down three years ago. A total of about 1,000 h.p. is required for driving the works, the system adopted being sets of gas engines located in various shops.

It is interesting to observe that these works are an example of development with growing business. Various other details are indicated on the plan which we need not dwell upon. We will merely note the connections of sewers, the entrances to Whitworth Street, Clayton Lane, and Pottery Lane, and the main tracks into and out of the works connecting to the Great Central Railway.

THE BRITISH WESTINGHOUSE WORKS.

The works at Trafford Park newly built by the British Westinghouse Electric and Manufacturing Company, Ltd., are full of interest from whatever point of view they are regarded: but for the present we consider the plan arrangements only. The firm was in the enviable position of being able to build brand new works for a business, in the conduct of which an extensive experience had been already gathered in America. There is therefore, nothing of a makeshift character, no hampering in design, through lack of space, or of capital. All the leading arrangements were planned before the works were begun. The approximate floor area of the buildings is 30 acres. With the exception of the offices, which are six stories high, and the galleries of the three narrow bays of the machine shop, the works are all laid out on the ground floor. All the shops run in one direction, in perfectly parallel lines, nearly north and south. The Bridgwater Canal bounds two sides of the area. A perfect system of standard gauge tracks connects the yard and shops with the Cheshire and the Lancashire lines. Turntables and sidings make rapid communication with the shops, the yard and the railway lines. It is not easy to realise the vastness of the system by a mere inspection of the plan, but there are about 10 miles of tracks within the area of the works, a length about equal to that from Enfield to London Bridge, or from the Bank to Richmond, as the crow flies. The immense machine shop measures 900 ft. in length, by 427 ft. in width. Its length, therefore, is close upon 200 ft. greater than that of the *Oceanic*. Its width is divided into five bays, the roofs being carried on steel columns. This shop alone has absorbed 9,000 tons of steel in its construction.

Communication between the shops is to be supplemented by powerful cranes. Two sets of overhead travellers will connect the northern ends of the foundries and the machine shop, and two similar craneways will run between the steel foundry and the machine shop. Numerous overhead travellers and other types of cranes and elevators also serve the interiors of the shops. The most ample provision therefore exists for the handling of material and work. Other details relating to the works will be noticed in their suitable connections; at present we are considering plan arrangements.

THE EMPRESS WORKS.

Another type of works is partly illustrated in the ground plan of the Empress Foundry, of Messrs. Isaac

Storey and Sons, Ltd., at Manchester, the staple productions of which are steam pumps, feed water heaters, condensing plants, brass fittings, coppersmiths' work, etc. This is a case of an old firm, established in 1837, at Knott Mill, in Manchester, outgrowing its environment, and migrating to Old Trafford, the works at which are shown in the plan on page 430. This also is an illustration of a rectangular area laid out with the object of very economical handling of work. The shops face Empress Street on one side, the Manchester, South Junction, and Altrincham Railway runs along the western boundary, and a siding connects it to the works. The Ship Canal Docks are close by. Narrow gauge tracks afford communication between the loading platform, the machine shop, the coppersmiths' shop, foundry, and fettling shop. The plan indicates very completely the inner arrangements of the shops, benches, lathes, cranes, and the rest, which are self explanatory. In these works the brass foundry and the coppersmiths' shop occupy larger relative areas than they have in previous illustrations. Only in a firm doing a specialised business do these departments assume such prominence. As much as two tons of brass can be melted at once. Each of these shops measures 100 ft. by 40 ft. In each, a clear space is left between the walls for travelling cranes. The roofs, by the way, are of saw-tooth type, with north lights. These shops were built some years before the machine shops and offices. The machine and erecting shops are 120 ft. long by 80 ft. wide. There is a 40 ft. clear space down the centre, served by a 10-ton overhead electric traveller, and two jib cranes of 30 cwt. capacity each. A gallery runs round three sides, occupied by light machine tools, used chiefly for brass finishing. Fitters' benches and machine tools are arranged under one gallery. Under another are works stores, and the testing room for steam and water tests. Under the third lies the tool room. The offices are storied buildings, the offices proper occupying the first floor. The warehouse and packing room are beneath, and a mess room is underneath this in the basement. There is also a room for the office staff, with kitchen and lavatory. The second floor is used for photographic processes, electric copying being employed, and here the drawing office is located. With these exceptions, and the galleries, the works are built on a ground floor system. As will be inferred from the details at the bottom right hand corner of the plan, the works are served by electricity. Both power and light are supplied thus. The main switchboard provides main feeders for both the power and lighting current to local distributing boards, in convenient places in the shops. The current from any dynamo can be used for power or lighting in any part of the works. The motors in the shops supply groups of tools through short line shafts.

THE BIRMINGHAM SMALL ARMS WORKS.

Works of quite a different character are those of the Birmingham Small Arms Company, Ltd. Here the dominant feature is the association of a large number of departments that are not so dissimilar in dimensions as those in a general engineers' works. The foundry, for example, is a small shop. The largest departments are the shops in which the component parts of guns and of cycles are prepared, and these are subdivided among several workrooms. It is an interesting illustration of the compact, self-contained type of works arranged mostly on rectangular dispositions, and well situated in regard to transit—a railway flanking one side, a canal the other, and one end. Two roadways intersect the shops.

THE REDMAN WORKS.

The next illustration is that of the ground plan of the machine tool works of Messrs. C. Redman and Sons, of Halifax. This is an example of a shop occupied wholly with the building of machine tools. It is a one-floor shop, the slight exception being the drawing office, and pattern shop, over the boiler and engine house. This is a new factory, built about ten years ago to take the place of previous shops which the business of the firm had outgrown. The building includes five bays, communicating with each other, the roof columns alone forming the divisions between bays. The three central ones are occupied with lathes and various machine tools, the two side ones being reserved for erecting—one for light the other for heavy tools. These are served by travelling cranes of five and ten tons power respectively. The offices are situated at one corner.

THE WITTON WORKS OF THE GENERAL ELECTRIC COMPANY, LTD.

The ground plan of the new Witton works of the General Electric Company, Ltd. (who have several other factories also), is roughly triangular in form, not the most economical or desirable. But it has the great advantage of being bounded on two sides by a railway and a canal. These are also works in which the industries carried on are very diverse in character; including the engineering section, the foundry, the carbon works, and the conduit works, which it is just as well not to crowd together. And above all, there is ample room for extensions to be made around each existing group of works.

THE BABCOCK AND WILCOX WORKS AT RENFREW.

The works of Messrs. Babcock and Wilcox, Ltd., at South Renfrew, are an excellent illustration of a great boiler factory, laid out on a rectangular plan. As the work is mostly heavy, an ample plant of tracks is laid down. A large plot of ground is available for extensions. The works are bounded on one side by a railway, on the other by a stream, on a third by a public road. The offices are at one corner, and these, and the pattern shop are storied buildings. The remainder are single floor shops. As there is a considerable amount of cast work in water-tube boiler work, the foundry is a big shop. The largest single building is the marine shop, where the boilers are erected. The plan does not indicate the extent of this, nor of the machine shops and those immediately adjacent. The marine shop for example, has four bays, and is covered by as many roofs, and the other shops are also of several bays.

LOCOMOTIVE ENGINEERING NOTES.

A LOCOMOTIVE COLOSSUS.

THE event of the past month in locomotive history has undoubtedly been the advent of the first of the new express engines designed for the Caledonian Railway by Mr. J. F. M'Intosh and built at the St. Rollox Works. This engine, No. 49, entirely transcends in point of dimensions and power all other types of passenger locomotives hitherto placed upon British metals. It also affords another amusing illustration of the utter futility of asserting any particular set of dimensions to represent "the ultimatum for the 4-ft. 8½-in. gauge." This "ultimatum" was reached—on paper—so long ago as the year 1850, when Mr. T. R. Crampton pronounced his eight-wheeled 8-ft. single-driver engine "Liverpool," which he designed for the London and North-Western Railway, to have fulfilled that limitation. He boldly pronounced it to be "the ultimatum for the 4-ft. 8½-in. gauge," intending it as a counterblast to Sir Daniel (then Mr.) Gooch's "Great Western" type, which had been deemed the "ultimatum for the 7-ft. gauge." Mr. M'Intosh believes, with much show of reason, that in his new locomotive colossus he, too, has produced an "ultimatum," as Mr. Crampton thought he had done in 1850, and as Mr. J. A. F. Aspinall thought he, too, had achieved with his No. 1400 in 1899. But "ultimatums" of this sort have an awkward knack of getting unexpectedly beaten, and there is already a rumour afloat that even this new Caledonian colossus is about to be surpassed by a North-Eastern engine of such gigantic proportions that there will be no room for any visible chimney at all outside the top of its enormous boiler.

ANTECEDENT COLOSSI.

The "ultimatum" of fifty-three years ago was a very mighty monster for those early days in railway history, and even now several of its dimensions would be deemed more than highly respectable. For example, its total heating-surface is stated to have amounted to no less than 2,290 square feet, which of course completely swamped the 1,952 square feet of the Gooch 8-ft. single-wheelers on the Great Western, and surpasses not only the 2,052 square feet of Mr. Aspinall's "1400" on the Lancashire and Yorkshire, and Mr. P. Drummond's "Castle" type on the Highland line, but also even the 2,275 square feet of the du Bousquet de Glehn "Atlantics" on the French Northern line. It also approaches very closely the 2,400 square feet possessed by Mr. M'Intosh's new giant, by Mr. W. Dean's No. 100 on the Great Western, and Mr. H. A. Ivatt's No. 251 on the Great Northern. This affords an apt illustration of the frequent untrustworthiness of mere statistical figures in matters of comparison. Heating-surface area is frequently quoted as if it were the sole touchstone of locomotive boiler power. Yet here we find an engine built fifty-three years ago which, tested by the gauge of heating-surface, possessed boiler power practically equal to that of nearly all the most recent British and French types. It is hardly necessary to set forth the fallacy of such a comparison, but it may be well to lay some stress on the fact that a square foot of heating-surface may be worth a great deal or a very little, according to its position and disposition. That vast area of 2,290 square feet in the old Crampton engine "Liverpool" was in reality not nearly so effective as half the area would have been if more judiciously disposed. An examination of the drawings and details at once shows that the tubes were too numerous and too closely crowded together to possess anything like their proper efficacy. Indeed, it has been said that a great part of the boiler as thus arranged was filled with mere froth of little real value in the production of power.

OTHER DIFFERENCES.

Further, whereas the Crampton "ultimatum," "Liverpool," of 1850 weighed but 35 tons, Mr

Locomotive Engineering Notes.

M'Intosh's No. 49 weighs more than double that amount, namely 72 tons. The Crampton engine had cylinders only 18 in. by 24 in.—a very large size, too, for those days, equalled only by the cylinders of the Gooch Great Western engines—the cylinders of the M'Intosh engine are 21 in. by 26 in. Again, the Crampton engine had only a single pair of driving-wheels 8 ft. in diameter and 14 tons total adhesion weight. The M'Intosh engine had six driving-wheels each of 6 ft. 6 in. diameter, and a total adhesion weight of 54 tons—18 tons per axle. Consequently, while the engine of 1850 had only 81 lb. of tractive force for every pound of effective steam pressure in the cylinders, the relative tractive force of the newest engine of 1903 is 147 lb., or not far short of being double. Further, the difference between the power of the two "ultimatums" is accentuated by the fact that the Crampton engine had a pressure of only 120 lb. per square inch, whereas the pressure in the M'Intosh engine is 200 lb. When, therefore, this enormous difference in the steam pressure is multiplied into the difference in relative tractive force and the still vaster difference between the adhesion weight available to utilise that tractive force, it will at once be recognised that the new locomotive colossus represents the aggregate power of several colossi such as that which was the wonder of 1850 and of the International Exhibition of 1851, although "Liverpool" was then regarded as equal in power to three of the ordinary London and North-Western locomotives of the day.

A PROCESS OF EVOLUTION.

With regard to the claim put forth that the Lancashire and Yorkshire engine No. 1400 represented the present-day "ultimatum" for the standard gauge—the word gauge being now taken to represent the loading gauge as well as the rail gauge—it was pointed out at the time by the writer of these notes that a large margin was still left for increase of power by the adoption of smaller driving-wheels than 7 ft. 3 in., by utilising the increased vertical space thus afforded in increasing the size of the boiler, by proportionately increasing the cylinder dimensions; also by supplying additional adhesion weight by means of an additional pair of coupled wheels. This view speedily received practical illustration of its justness. The 58¾-ton weight of the Aspinall engine was soon eclipsed by the 62¼ tons which Mr. Wilson Worsdell's six-coupled "2001" North-Eastern class weighed in working order, while six-coupled 6-ft. wheels associated with cylinders 20 in. by 26 in. gave a huge increment of nominal tractive force as compared with the four 7-ft. 3-in. wheels and 19-in. by 26-in. cylinders of the Lancashire and Yorkshire engine. The doubt suggested was whether the North-Eastern boiler, with its 1,769 square feet of heating surface, would supply live steam sufficient to give efficiency as great as that obtained from the Lancashire and Yorkshire engine with 19-in. cylinders supplied by 2,052 square feet of boiler-heating surface. The next step in the evolution of locomotive magnitude was again taken by Mr. Worsdell with his "2111" type, which [illegible] 6-ft. 8-in. coupled wheels, this dimensional advance involving about five tons additional weight, a total of 67 tons thus being reached. Then came Mr. Dean's Great Western "100," weighing 69 tons, with six-coupled 6-ft. 8-in. wheels like the North-Eastern [illegible] by 26 in. and with 2,400 square feet of heating surface instead of 1,769. And now we get to the new Caledonian mammoth with six-coupled 6-ft. 6-in. wheels, cylinders no less than 21 in. in diameter with a 26 in. stroke, a boiler-heating surface of 2,400 square feet, a steam pressure of 200 lb. with four separate safety valves to relieve it when needful, and a total weight of 72 tons exclusive of the tender.

FURTHER POSSIBILITIES.

It may [illegible] seem impossible or at least improbable that such dimensions as these last could be exceeded within our British load-gauge limits, at any rate in the case of express engines. So far as engines intended for goods and mineral traffic are concerned, it may be that even Mr. M'Intosh's Caledonian "600" type—which has the same boiler and cylinders as the new No. 49—does not represent an "ultimatum." But with express engines the difficulty of enlargement within the gauge limits available becomes greater and greater at each fresh step, just as does each extra knot of speed in the case of the largest and fastest ocean steamers. It is true that the Société Alsacienne de Constructions Mécaniques is now building at Belfort, to the order of M. Solacroup, the Ingénieur en Chef du Matérial et de la Traction of the Paris-Orleans Railway, a de Glehn compound of the "Atlantic" class which will weigh some eight tons more than do the famous du Bousquet-de Glehn compounds on the Chemin de Fer du Nord. That is to say, the new Orleans engine will weigh 73 tons in working order, exclusive of the tender. Sufficient dimensional particulars are not yet available for it to be stated definitely whether or not this engine could be got within British loading-gauge limits. But, at any rate, the new du Bousquet-de Glehn engine of the Nord type, which is being built for the Great Western Railway of England, will have a material increment of adhesion weight as compared with the French locomotives of the same type, carrying 17½ tons on each axle, instead of 16, and will, therefore, probably weigh quite 70 tons. Moreover, the new North-Eastern engine foreshadowed by Mr. W. Worsdell in an address which he recently delivered, may be expected to exceed even all these totals in point of size and weight. Seeing that the top of its boiler is to stand so high as to leave no room for chimney or dome or safety valves to appear above its apex, an idea of resultant general magnitude is suggested such as can have had no possible parallel in previous European locomotive history. It will be most interesting to see how such prodigious dimensions will be disposed. A rumour has been current that the North-Eastern monster is to be a four-cylinder compound, either on the de Glehn system or some cognate plan, and is to have two 15-in. high-pressure cylinders and two 25-in. low-pressure cylinders. If so, there is a foreshadowing of theoretical power entirely transcending anything that has yet been brought to play in this country. This, however, is a matter to be viewed only along "the dim vista of the future," and may be regarded as still *in nubibus*.

PREDICTED "PRAIRIES."

In the course of the discussion which took place on Mr. Cowan's very able and "informing" Paper on American Locomotive Practice, which was read before the Institution of Civil Engineers on the 31st March, Mr. G. J. Churchward, the new Locomotive Superintendent of the Great Western Railway, made some suggestive remarks as to the possibility of future increment of locomotive power in express services. His idea seemed to be that the next new departure would consist in the adoption of what is known in the United States as the "Prairie" or "2–6–2" type, in which the six-coupled wheels are under the middle of the boiler barrel, between the smokebox and firebox, while a two-wheel or Bissell bogie or "pony truck" is placed under each end of the engine. This plan has several advantages to recommend it. The weight of the engine is used in the best possible manner for the purpose of adhesion, and wide scope is left for the extension of the firebox, while it may be that the design is recommended by a certain symmetry of aspect of the kind that has always gone far to commend single-wheelers to popular approval. The "2–6–2," rather absurdly entitled the "Prairie" type, although hitherto unknown in Britain, has long been in common use in, at any rate, one important British Colony—New Zealand. So far back as the year 1883—twenty years ago—when express passenger engines of increased power were required, it was decided to adopt six-coupled wheels instead of four. The original suggestion was that the "4–6" arrangement—which American engineers are accustomed to know by the vague designation of the "ten-wheeler" class—should be employed in the case of the new locomotives. It is difficult to ascertain who among the New Zealand engineers ought to be accredited with the origination of the "2–6–2" idea, no fewer than three having laid claim to it in conversation with the present writer. Be that as it may, the plan was decided upon and a number of engines of that type were ordered both from Britain and from America, and these have since been supplemented by others. They proved exceedingly efficient and handy, hauling heavy loads with great ease when employed on goods traffic, and attaining speeds in express service which had hitherto been unheard of on the 3-ft. 6-in. gauge. The writer of these notes has been on the foot-plate of engines of this class when, on the one hand, a train of 81 wagons loaded with wheat was hauled at the rate of 25 miles an hour on the level, and in another case when a lighter train was run at the rate of 60 miles an hour for 15 consecutive miles and a maximum rate of 64·2 miles an hour was attained. The latter result had previously been deemed quite impracticable on so narrow a gauge.

POSSIBLE EXTENSION OF THE "PRAIRIE" TYPE.

It may be that by the time the occasion is deemed ripe for introducing the "Prairie" type in Britain, it may be found preferable to follow the lead of New Zealand also in introducing the latest development employed in that distant colony. This consists in an enlargement of the "Prairie" engine and consequent substitution of a four-wheel bogie for one of the two-wheel pony trucks. This plan has many obvious advantages and has proved distinctly successful in the colony of its adoption. It virtually provides a six-coupled "Atlantic." It may be that even this development will be followed by yet another, and that we may see a type of British express engine having six-coupled wheels of moderate size under the middle of an enormous boiler, while the leading and trailing ends of the engine are carried each on its own four-wheel bogie, thus producing a fourteen-wheeled locomotive which would be classed as "4–6–4" under the system which is now coming into such extensive American adoption.

C. R.-M.

AMERICAN RÉSUMÉ.

NEW YORK, April 10th, 1903.

THE BRAZILIAN IRON ORE DEPOSITS.

The extensive deposits of hematite that have lately been discovered in Brazil, particularly in the vicinity of Pico d'Itabira do Campo, have attracted considerable notice in this country since the appearance of the December bulletin of the Bureau of American Republics. The hematite occurs in beds frequently 90 ft. to 150 ft. thick, and is one of the purest forms of iron ore known, containing as high as 66 to 70 per cent. of iron. Mr. W. H. Herdsman, an authority on the subject, says that the Pico d'Itabira is a veritable mountain of iron, and the first that he has found in his twenty-five years' experience that justified the title. He further states that there can be little doubt that not less than 10,000,000 tons are out-cropping at this one point, while a similar out-crop is found some ninety-five miles distant, and the whole adjoining country is covered with iron ore in every direction, which gives a fair idea of the immensity of the Brazilian ore deposits.

A NOTABLE UNDERTAKING AT SAN FRANCISCO.

The newest and one of the best dry docks in the United States has been completed at Hunter's Point, San Francisco. It is the property of the San Francisco Dry Dock Company, and has been about two years in building. The dimensions are: length, 750 ft.; width at top, 122 ft.; width on a level with the top of the keel blocks, 80 ft.; depth of water at high tide, 28 ft. It was built by Mr. Howard Holmes, and can comfortably accommodate the largest vessel afloat. When the pontoon gate is closed the water is withdrawn by three centrifugal pumps, having a combined capacity of 120,000 gallons per minute. During a recent docking of the battleship *Ohio*, the dock was emptied in two hours and five minutes from the time the pumps were started.

TESTING FOR DANGEROUS GASES.

The importance of furnishing an abundant supply of fresh air to workmen engaged in tunnel construction, especially where there is danger of a possible presence of explosive gases, can hardly be over-estimated. In a paper read before a recent meeting of the American Public Health Association, Mr. Joseph W. Ellms, of Columbus, Ohio, described the apparatus and methods employed in tests conducted by him for determining the presence, in tunnel headings, of inflammable gas and carbon dioxide, and their percentages. A Shaw gas tester was used for the first, the tester affording a mechanical means of producing, measuring and exploding adjustable mixtures of air and illuminating gas. As a standard a first determination is made of the proportion of gas and pure air which will just fail to explode. The subsequent use of the air to be tested in place of the pure air will cause an explosion if there is a trace of inflammable gas, and the measured diminution of illuminating gas necessary to prevent again an explosion fixes the percentage of gas in the impure air. In the testing for carbon dioxide the sample of air is transferred to calibrated bottles of about one litre capacity, into which ten cubic centimetres of a standard solution of barium hydrate are introduced, the bottle being then closed with a rubber stopper and thoroughly shaken. After standing five or ten minutes the excess of barium hydrate is titrated with a standard oxalic-acid solution and corrections made for temperature and barometric pressure, the results being stated in parts per one hundred for standard conditions.

THE DURABILITY OF PRESSED STEEL CARS.

An evidence of the durability of pressed steel cars was given a few days ago at Pittsburg, when the brakes of a car, while being shifted, failed to work at the proper time, with the result that the car crashed into the bumper, the upper part of the car being forced over the bumper against a substantial stone wall. The latter was cracked in four places, and was almost ready to fall, but the car was damaged so slightly that it was able to resume its trip without any attention whatever.

ORE-CARRYING ON THE GREAT LAKES.

Last season's ore-carrying trade on the Great Lakes was the greatest in history, and next year's is expected to be even greater, probably reaching as high as 29,000,000, and possibly

30,000,000 tons. It is stated that an order has already been placed by the United States Steel Corporation for twenty ore-carrying vessels, with a capacity of 9,000 tons each, being the largest yet constructed.

VENTILATION AND HEATING.

One of the developments in engineering in the United States that is worthy of more than passing notice is that which has taken place, particularly in the last ten years, in heating and ventilation. Not only is it now generally conceded that all buildings where people are likely to congregate must be thoroughly ventilated, but means are taken to provide by mechanical methods for the desired circulation of air, and at costs that are truly considerable. One of the most interesting of the recent installations of this character is that forming part of the mechanical equipment of the Lying-in Hospital, New York, the gift of Mr. J. Pierpont Morgan to a charitable society of the city. The building encloses 1,862,100 cubic feet, and for ventilation there are sixteen fans (the largest 9 ft. in diameter), connected to some three miles, or 140 tons, of galvanised iron ducts. The fresh air supply is warmed by 5,275 square feet of steam coils in the air passages. Besides that, the steam radiating surface in the rooms amounts to 22,500 square feet, and over half of this is enclosed by air-tight sheet steel casings, which are given a hard, smooth, finished surface continuous with the walls of the rooms, to prevent the collection of dust and the cultivation of bacteria. There are 157,820 cubic feet of air exhausted from the building per minute by the exhaust fans, and the average rate of change of air for the rooms connected to the system is 7 to 7½ times an hour. The velocities of the air is in general 24 ft. per second in ducts, 12 ft. in flues, and 6 ft. at the room openings. In the wards 8,100 cubic feet of air are supplied per hour for every bed. The enclosed coils, which consist of one row of 1¼ in. pipe, twelve pipes high, placed against the inner surface of the steel casing, have been found to give off 150 British thermal units per square feet of coil surface per hour. Each coil is divided into two parts, each part connected to a separate pair of risers; eight pipes are in one part, thermostatically controlled by the temperature of the room, and four pipes in the other, thermostatically controlled by the temperature out of doors. Mr. Alfred R. Wolff is the consulting engineer responsible for the designs.

FRICTION OF BALL BEARINGS.

At a recent meeting of the American Association for the Advancement of Science, Professor M. J. Golden, of Purdue University, presented in a paper the results of a series of tests made on ball bearings of the form in use with bicycles and shop-shafting. The balls were 0·25, 0·3 and 0·5 in. in diameter, and were tested at speeds of 200 to 2,000 revolutions per minute. Above 2,000 revolutions the balls and racers were destroyed by becoming pitted, and with heavier loads the balls broke in two parts, apparently shearing apart. The coefficient of friction was calculated to be 0·00475, or less than one-half of one per cent. He devised a formula for friction as follows: $\text{Friction} = L\,(0{\cdot}005 + d \div 1{,}000 + 0{\cdot}005D)$, in which D is the diameter in inches of the path of the balls on the racers; D, the diameter in inches of the balls; and L, the load in pounds.

VALUE OF OIL RINGS IN BEARINGS.

It is probably not generally known that a shaft may be highly insulated electrically from the bearing by the film of oil which envelops the shaft, and that the oil film is capable of withstanding a comparatively high electric pressure. According to some measurements recently made by Dr. A. E. Kennelly and Mr. C. A. Adams, the short circuit of the bearings of a 125-volt 6-kilowatt Edison bipolar dynamo, having a normal speed of 1,800 revolutions per minute, ceased to exist above a speed of 100 revolutions. The electric resistance was found to be 8·8 megohms in each of the bearings, which were 5 in. long and 1½ in. internal diameter. The insulation was found to break down periodically owing to accidental contacts between the brass oil rings and the sides of the bearing slots, but when the rings were lifted it was found that the insulation entirely disappeared, and was not restored until the rings were replaced and set in motion. This experience is a good demonstration of the importance of oil rings in maintaining an adequate flow of oil through a bearing.

THE VISIT OF THE INSTITUTION OF ELECTRICAL ENGINEERS TO ITALY.

BY

THE EDITOR.

ON Wednesday and Thursday, April 1st and 2nd, about one hundred and twenty-eight members of the Institution of Electrical Engineers, accompanied by twenty ladies, left London for Northern Italy, to visit some of the more important electrical engineering undertakings there, at the kind invitation of the Associazione Elettrotecnica Italiana. The party was divided into two sections, which travelled separately to Lucerne, and were there united.

The journey of the first party to Lucerne was uneventful. At Laon, those who were fortunate enough to have secured berths in the two sleeping cars removed their hand baggage there, and very quickly "shook down" for the night. Those who were hardened to the doughiness of the pillows and the shortness of the blankets, managed to fall asleep, but all were aroused at the early hour of 5 a.m. by the arrival at the Swiss frontier.

As is usual, the first thing in the morning, after a night in the sleeping car, a general disinclination for social intercourse was observable, but some steaming hot *café au lait* was available at Bâle, and conversation thereafter became more vivacious. Lucerne having been reached about 10 a.m., the remainder of the day was left free for the members to make their own arrangements. Some of the more energetic proceeded to make an ascent of the Rigi, while others more sedately inclined, disposed of their *déjeuner*, and had a sail up the lake to Brunnen. The Lake of the Four Cantons looked as charming as ever, and presented an ever-changing vision of gorges and torrents, picturesque châlets, and snow peaks shrouded in mist.

The St. Gothard Railway.

An early start was made next morning (Friday), and at this point the really interesting portion of the trip began. The St. Gothard Railway, begun in 1872, and completed and delivered over to public traffic in June, 1882, has always been of great interest to engineers. The amount of labour which its construction involved may be gauged from the fact that there are no less than seventy-six tunnels and galleries,

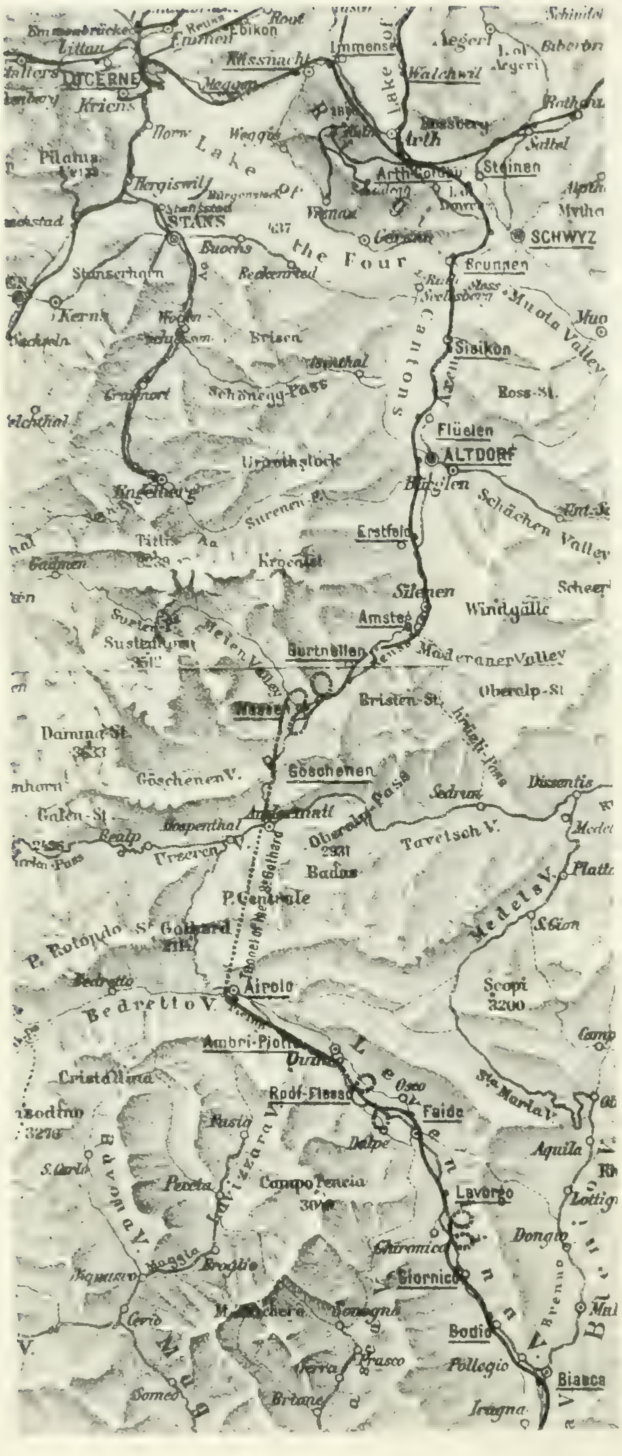


FIG. I. MAP OF THE ST. GOTHARD RAILWAY.

Showing the tunnel through which the party travelled.

with a total length of twenty-nine miles. The great tunnel through the St. Gothard, about nine miles in length, being the longest tunnel in the world, aroused general enthusiasm, and as the train plunged into the entrance, watches were universally consulted. Since the beginning of 1899 the tunnel has been artificially ventilated by means of the Saccardo system of ventilation, which sends a constant supply of fresh air into the tunnel, so that the unpleasantness caused by the smoke of the engines is no longer occasioned. Seventeen minutes later, as we emerged into the blinding sunlight, it was difficult to believe that we were still in Switzerland. The architecture, the costumes, and physiognomy of the people, the very signs over the doorways, were all Italian. As the train dashed down the valley of the river Ticino, we soon perceived, in the luxuriance of the vegetation, the azure of the skies, and the unwonted balminess of the atmosphere, that sunny Italy was certainly not far away.

Arrival at Como.

Como was reached at 7 p.m., and to the surprise of the party the crashing of the Civic Band as the train drew up at the platform resolved itself into the familiar strains of the British National Anthem. The Mayor, Cavaliere Sinati, accompanied by Count Reina, Professor Bonardi, Engineer Perti, and other gentlemen, received the President, Mr. R. Kaye Gray, and the leading members of the party, who were formally introduced by Dr. Silvanus P. Thompson. The whole of Como had turned out to see the sight, and lined the thoroughfares as the procession of carriages and brakes conveyed the visitors to their various hotels. After dinner nearly all the members of the party strolled through the streets to see the statue of Alessandro Volta, which was illuminated by a searchlight thrown from a neighbouring building.

SATURDAY, APRIL 4th.

On Saturday, the 4th ult., in glorious weather, the party embarked on board a special steamer, and nothing more delightful can be imagined than the sail up the Lake of Como, which was the next item in the programme. All along the banks nestle picturesque villages and gay villas surrounded by luxuriant gardens and vineyards; these, together with the indescribable blue of the water, the azure sky, and the towering snow-capped mountains, make up a picture that it would be difficult to equal, and certainly impossible to excel in beauty.

The President of the Milan section of the Associazione Elettrotecnica Italiana, Signor Bertini, and the Hon. Secretary, Signor G. Semenza, and Herr Bláthy of the Ganz Company of Buda-Pesth, joined the party at Como. On arrival at Varenna we entrained for Sondrio on the Valtellina Railway.

The Valtellina Railway.

These sixty-seven miles of railway, the motive power of which has been transformed from steam to electricity, were formally inaugurated on September 4th, 1902, and are being operated on the Ganz cascade system, of which so much was heard two years ago, in connection with the electrification of the Metropolitan Railway. The hydraulic power house, with turbines of 6,000 h.p., is at Morbegno, water being taken from the river Adda. Three-phase current is generated at 20,000 volts, and carried by overhead conductors to nine transformer stations, where it is transformed down to 3,000 volts and taken to the two trolley wires, the rail forming the third conductor, and thence direct to polyphase motors on the cars. The trains on the electric line are made up of the old rolling stock, plus the new motor cars and the new goods locomotives.

The cars fitted with electric motors capable of developing 600 h.p., have been constructed with a small cabin at either end, in which is located the apparatus by which the driver controls the starting, running, and stopping of the train. They weigh about fifty-three tons each, have a seating accommodation for fifty-six passengers, and during the trip the one attached to the special train, consisting of five or six ordinary carriages, frequently exceeded a speed of forty miles per hour. The objectionable smoke of the steam locomotive was noticeable by its absence. Grades and curves, which were

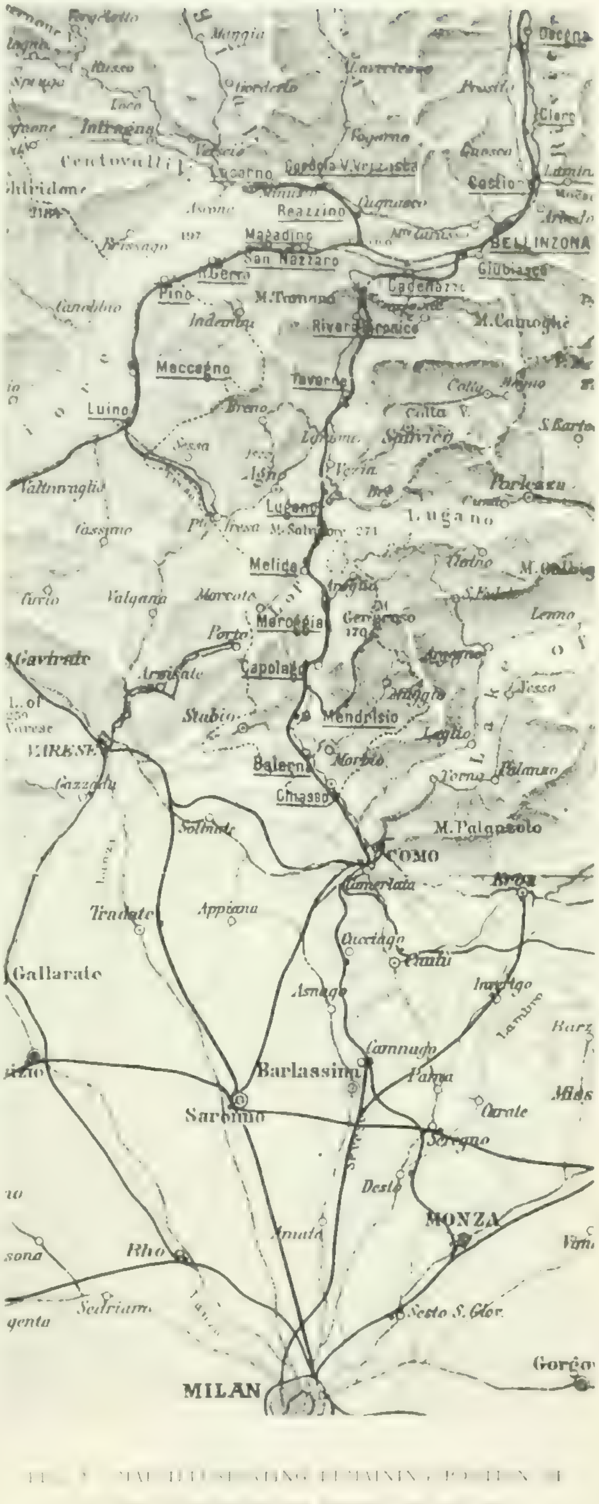


FIG. 8.—MAP ILLUSTRATING REMAINING PORTION OF RAILWAY JOURNEY TO COMO AND MILAN

numerous, were easily surmounted, and a regular speed was maintained throughout the journey. There was practically no evidence of alteration to the permanent way beyond connecting together the rails at every joint with a stout copper wire.

Steam locomotives can be run over this section of the line, but we should say their use in any large number is not to be recommended, as there would be a great likelihood of the smoke settling on the insulators in the tunnels. The goods traffic is handled by specially constructed electric locomotives, weighing about forty-six tons, of 600 normal horse power, which are capable of drawing from 400 to 500 tons up the steep inclines of the line when the rails give sufficient adhesion. The management have been so satisfied with the performance of these locomotives for goods trains that they have decided to have some built for the conveyance of passenger trains of 250 tons, at a speed of thirty-seven to forty-four miles up grades of 1 in a 100.

All the way to Sondrio great interest was evinced by the party in the construction and working of the line. It is said that no accident in any part of the whole installation has yet occurred to any of the public, nor to the car-drivers or conductors, and the general success of the undertaking can be gauged by the fact that a further length of thirty-one miles, giving a connection with Milan, will be converted to electrical working as soon as possible. As the train sped along at an exhilarating speed of forty miles per hour, several engineers were heard to express regret that England, in the matter of electric traction on main lines, was behind the agricultural districts of Northern Italy.

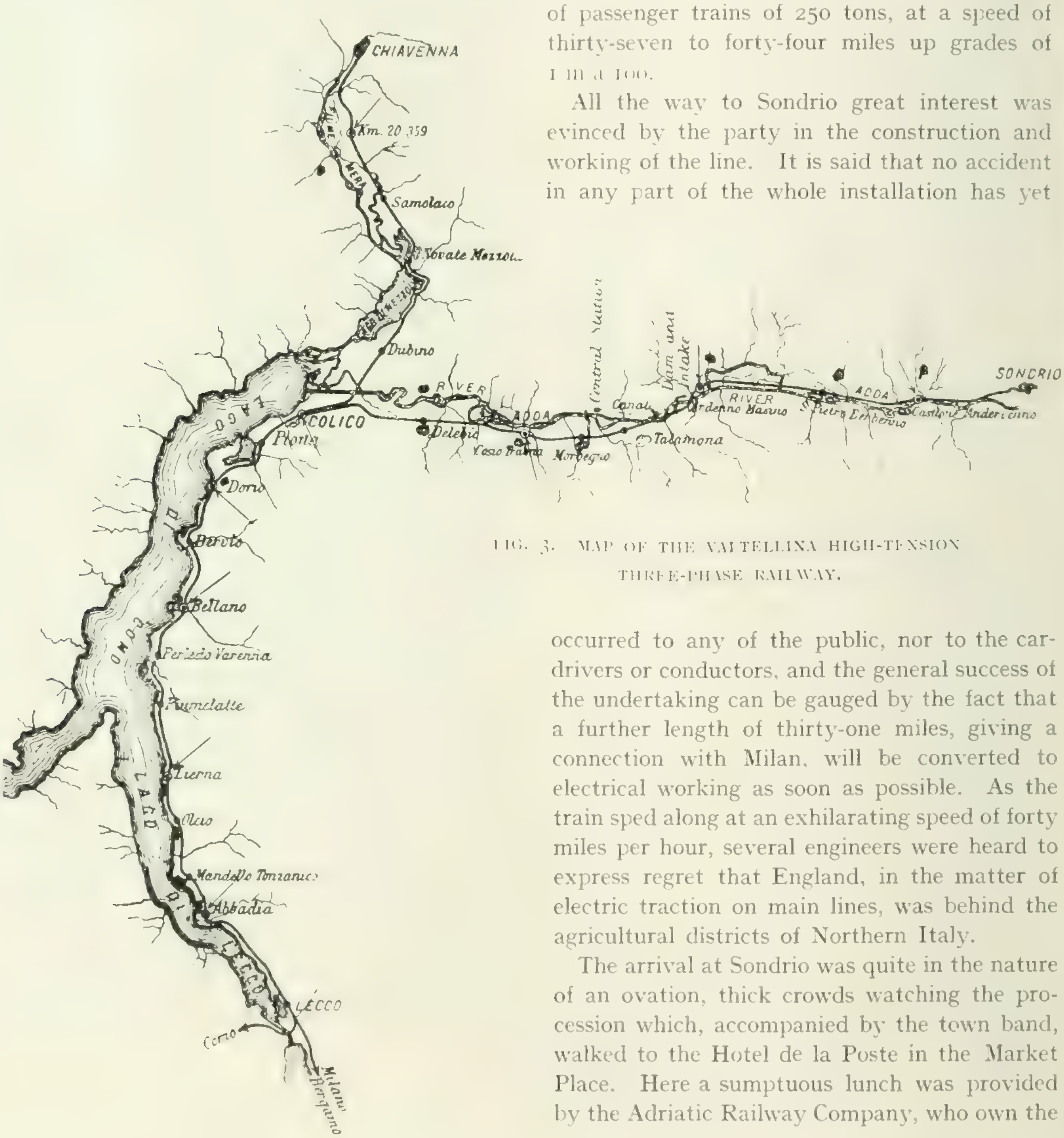


FIG. 3. MAP OF THE VALTELLINA HIGH-TENSION THREE-PHASE RAILWAY.

The arrival at Sondrio was quite in the nature of an ovation, thick crowds watching the procession which, accompanied by the town band, walked to the Hotel de la Poste in the Market Place. Here a sumptuous lunch was provided by the Adriatic Railway Company, who own the

VISIT TO THE VALTELLINA RAILWAY.
Embarking on board the special steamer on Lake Como at 8.15 a.m.

VISIT TO THE VALTELLINA RAILWAY.
Another snapshot taken two minutes later, including Signor Bertini, Mr. R. Kaye Gray, Prof. Gerard, Col. Pescetto, Mr. Hammond, and others.

A GROUP ON BOARD THE STEAMER ON LAKE COMO
Including Mr. John Gavey, Mr. Robert Hammond, Mr. Henry A. Mavor, Mr. R. Kaye Gray, and Mr. H. Alabaster.

INSPECTING THE ELECTRIC LOCOMOTIVE AT BELLANO, ON THE VALTELLINA RAILWAY.

Valtellina line. Signor Bertini welcomed us to Italy in the name of the sister association, and this was suitably replied to by the President. Altogether a most enjoyable couple of hours were spent in the large tent, erected in the garden, which was fragrant with the scent of roses and early blossoms. After the loyal toasts had been drunk, the party were played again to the station, and to the accompaniment of genial cheering departed for Morbegno.

The Morbegno Power Station.

After a walk of a mile and a halt in the genial sunshine the power station was reached. This is supplied with water from the river Adda, by a tunnel through two riveted iron pipes. In the turbine house there are installed three turbo-dynamo sets of 2,000 h.p. each, although at present one set is sufficient for the train service. There is room for a fourth set of 3,000 h.p. to 4,000 h.p. output. The turbines supplied by Ganz and Co. are of the Francis type, and run at a speed of 150 revolutions per minute. The effective fall amounts to 100 feet, which at high water can be reduced to 89 feet, and occasionally even to 86 feet. The 2,000-kilowatt 20,000-volt three-phase alternators were supplied by Schuckert and Co., Nürnberg.

The apparatus that attracted the most general interest was the jet lightning arrester just outside the power station. This consists of three jets of water, each about 10 in. in length and $\frac{3}{4}$ in. in diameter, from earthed nozzles squirting upwards into umbrella shaped basins connected with the transmission lines. Should one of these be struck by lightning, instead of damaging the apparatus in the power house, the arrester acts as a perfect conductor to earth.

In the evening at Como an electrical illumination, representing the national colours of England and Italy, was given by the Volta Society in the principal square, and was much admired.

A TRANSFORMER HOUSE ON THE VALTELLINA RAILWAY.

THE FIRST CARRIAGE, CONTAINING THE WREATH TO BE LAID ON THE TOMB OF VOLTA, LEAVING THE HOTEL PLINIUS, COMO.

Mr. R. Kaye Gray (President) is seated on the right, and Professor Silvanus P. Thompson, D.Sc., F.R.S. (Past-President), on the left.

SUNDAY, APRIL 5th.

Laying a Wreath on the Tomb of Volta. At ten o'clock on Sunday morning the President and most of the members of the party left the Hotel Plinius for the mausoleum of Alessandro Volta to lay a wreath of immortelles on the tomb in the name of the Institution. Some fifteen vehicles of every shape and size drawn by one, two or four horses fell into procession after the first carriage, containing the wreath, and occupied by Mr. Gray and Professor Thompson. As the *cortège* wended its way along the delightfully wooded valley leading to Camnago, the strains of the band of the "Corps of Divine Providence," which had been sent by the Institute to greet our arrival, were heard from some neighbouring heights.

A minute gun was fired at regular intervals just before the gate of the little cemetery was reached, and here a guard of honour composed of the Como Fire Brigade was drawn up. On the steps were standing Signor Cavaliere Vincenzo, Mayor of Camnago, Cavaliere E. Linati, Mayor of Como, Professor A. Volta (grandson of the great philosopher), and other distinguished gentlemen.

Every head was reverently bared as the ceremony of placing the splendid and imposing wreath in the crypt was performed with much solemnity.

Cavaliere E. Linati, Mayor of Como, in an eloquent speech in Italian, said :—

> Ladies and Gentlemen,—In this hour of profound emotion, my poor inadequate words ought only to express the gratitude of Camnago Volta for the momentous visit of this noble assembly, before which I reverently bow. Yet I cannot but elevate my thoughts to the cause of this high honour—to that great one who, consecrating this hill as a monument to his eternal repose, left it a heritage of honour and glory which you, with your illustrious presence, magnify! Yes! Alessandro Volta, to whom humanity owes that great revelation that tore the veil of ignorance from the dying eighteenth century, and who illumined the world with his sparks, pointed out to science the upward paths to tread. Fervent apostles of physical research, with skilled and modern applications of his discovery, have astonished the world and immortalised his great name.
>
> It is not, however, given to one to enter further into this subject, as it is too elevated for the scientific attainments of the speaker. Therefore I close these few words, recalling how, four years ago, on this selfsame tomb, the renowned Professor Thompson (who, I am glad to see, is among us again) bore the greeting of the English Electrical Engineers, a greeting that I beg to exchange to-day, with fervent affection, in homage to the science that, above every human passion, has made us brothers at this sanctuary.
>
> I thank you again, ladies and gentlemen, for the honour rendered to the modest Commune of Camnago Volta, that will brand this memorable day with indelible, grateful, and perennial memories.

The President of the Institution, Mr. R. Kaye

LAYING A WREATH ON THE TOMB OF VOLTA AT CAMNAGO, IN THE NAME OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

Professor Alessandro Volta [illegible], who is the grandson of Volta, [illegible] standing between the President and Mr. John R. Hewett, the latter [illegible] presenting [illegible] of the Institution of Electrical Engineers [illegible].

Alessandro Volta was born at Como in 1745, and died there in 1827. He was successively Professor of Physics at the Gymnasium in Como, and the University of Pavia, where he invented the electrophorus and electroscope; he also devised several other electrical appliances, and in 1800 invented the Voltaic Pile, the far-reaching consequences of which were dealt with in Professor Thompson's speech, delivered at the tomb.

Gray, in depositing the wreath, spoke in French to the following effect :—

In the name of the Institution of Electrical Engineers of Great Britain, and during the presence in Como of our fellow-members of this body, I lay a wreath on the tomb of Volta, as a mark of veneration for one whose fame has lasted for more than 100 years, and whose philosophic thought and indefatigable industry have rendered great services to mankind.

PROF. SILVANUS P. THOMPSON, D.SC., F.R.S. (PAST PRESIDENT).

Mr. J. Gavey, Vice-President of the Institution, and Engineer-in-Chief to the British Post Office, addressed the assembly in the French language, as follows :

I much regret my inability to address you in your beautiful Italian language, and, further, it is impossible in any language to do justice, in a brief address, to one who may be said to have laid the foundation of our modern electrical engineering. I simply, therefore, content myself by asking you to accept on behalf of the Institution of Electrical Engineers of Great Britain the assurance of the deep feeling with which we pay homage at the tomb of the great Italian Volta, a man whose name is honoured and revered throughout the civilised world. That his spirit still lives amongst the inhabitants of his native land and that his mantle has fallen on worthy shoulders is shown by the carrying out of the great electrical works which we Englishmen have travelled so far to see. That this spirit of enterprise may continue, and that it may result in the further development of the resources and in the increase of the prosperity of this magnificent country, is the fervent hope of your friends and well-wishers, your English visitors.

Dr. Silvanus P. Thompson then delivered an eloquent address in Italian, which was listened to with rapt attention, and was much appreciated. The following is a free translation :—

Honourable Mr. Mayor, eminent colleagues, members and friends,—We have come here to offer our respects to the immortal memory of a man whose name is kept in perpetual reverence by all the civilised world. Here on the Italian soil, under the beautiful sky of Italy—Italy, the mother of nations—we pilgrims, sons of another country, born under another sky, among the grey fogs of the north, we wish to add to the homage of other nations our tribute of faithful and everlasting memory.

It is, perhaps, superfluous to lay stress on the intellectual obligation due from science, and much more from practical science, to Alessandro Volta. His name will remain eternally associated with the inventions of the Electrophorus and of the Voltaic Pile. Truly, he was more than an inventor : he was a scientist of the first order, an investigator of great genius, who accomplished many conquests in many departments of physical science, who did many things, but who touched nothing without adorning it.

In the course of his laborious studies, in the midst of his duties as professor of the University, he made celebrated discoveries relating to the source of the electric current, beginning with the Electric Pile, which he invented. He is honoured as a great inventor, as an apostle (one may say) in practical knowledge, who by his intellectual power mastered the rough forces of nature, and converted them afterwards to the service of human civilisation. Since the invention of printing, which multiplied learning and the diffusion of ideas, and, later on, the invention of steam as a motive power, which not only multiplied industries and the mechanical power of man, but also quickened and facilitated the contact of people with people, the progress of civilisation and of science has equally multiplied and increased. But no other discovery contributed so much to the perfection

MR. JOHN GAVEY (VICE-PRESIDENT), Engineer-in-Chief to the British Post Office.

Electrical Engineers' Visit to Italy.

[illegible] Volta. Without this initial discovery we should not have had the discovery by Faraday of the electric rotations, the beginning of the principle of the electric motor, a discovery followed, many years after, by the discovery—much more important—of induction, the principle, in fact, of all dynamos and transformers. With the continuous development of science, we have arrived at the knowledge of many things unknown at the time of Volta. All the phenomena of electromagnetism, the mechanical generation of electric currents, the transmission, distribution and utilisation of electric power, telegraphy, and telephony, the new horizon of electric waves, all appeared in the last century, after his death. The fundamental principle of all these wonderful developments was due only to this great man. In all these developments Italy has taken a great part. Italy has never ceased to produce worthy successors to Volta in electrical science, as well amongst those who carried forward the torch of research as amongst those who made use of the forces of nature for the advantage of man.

We are happy to know, and we congratulate ourselves with you, that the developments of electrical industry in Italy have greatly contributed to the prosperity of this great country, and we modest followers of those studies which Volta so grandly made, realising the greatness and immensity of this new world opened up by him, come to his tomb to salute his memory. At the same time we make this homage to him and to the memory of those true splendours of past centuries by which Italy acquired the well-merited name of "the land of the great." We remember, too, that we are also citizens of a nation where science flourishes with great development, and where, from time to time, great personalities have lived. If Italy can boast of the names of Galileo and of Leonardo da Vinci, we can also boast in England of Gilbert, the father of magnetism, of Newton, the creator of natural philosophical mathematics. You Italians have Volta, we are proud of Faraday. But neither Galileo nor Newton nor Volta nor Faraday belongs exclusively to any one nation. Great men of such a kind belong to the whole world, and we pilgrims of science gather once more around the tomb of Volta, the greatest benefactor of humanity, in order to render our tribute of reverent knowledge and of universal recognition.

Professor Alessandro Volta made an eloquent reply in Italian. The following is a translation:

Ladies and Gentlemen,—In coming to Italy on your long scientific tour, you did not forget the Comasco electrician, and have brought a splendid crown of art to the tomb where he reposes. Permit his descendant to remark that this is but a continuation of the noble relations that tied his life to learned England.

The great Volta searched and found in England wide fields of culture ; Crawford and Black were his favourite authors ; he spent many months in your country in the year 1782, and while there he became acquainted with its great and numerous industries, and had occasion to see the first railroad at Coalbrookdale, of which he wrote enthusiastically to Italy. He visited the most renowned academies, and was friendly with such men as Priestly, Watt, Percival, Cavendish, Banks, Davy, and many others ; and he ultimately showed his respect for English science by giving his first academical lecture at the Royal Society in London in the same year, reading his famous memorandum on the electrometer condenser invented by him—that simple yet marvellous instrument that was the first stepping-stone to the great discovery.

The Royal Society appreciated the merit of Volta, and seven years before the invention of his cell, it had already nominated him effective member of the society, almost as a prelude to his immortal discovery ; and it was even so, for, before communicating to any other the invention of his cells, Volta first of all wrote of it to the Royal Society in his classical letter dated March 20th, 1800, addressed to the President, Sir J. Banks.

To-day history repeats itself ; a young Italian, willing and worthy, proposes to himself a problem such as only those who have the strength to win, can achieve ; and behold, in England he finds help and support for his first faltering steps that quickly become enormous strides ; for, if Marconi had not the moral courage and material encouragement of Preece, he might never have won, or, at least, his victory had been much delayed.

I take pleasure, ladies and gentlemen, in recalling all this, here and at this moment, when you confirm these sentiments that your noble country professes for the studious, no matter to what nationality they may belong.

It is these that impart to your gracious homage to Volta an immense value and particular meaning, and I am glad to express these sentiments while I beg to offer you my sincere and affectionate greeting.

Mr. John R. Hewett, in depositing on behalf of the students of the Institution a handsome bronze memorial plaque, subscribed for wholly by the students, said :—

Ladies and Gentlemen,—Representing, as I have the honour to do on this occasion, the student members of the Institution of Electrical Engineers, I beg to present the memorial shield of bronze, designed by Mr. Gilbert Bayes, and subscribed for by the students, as a token of the deep respect in which we revere and honour the memory of the great Italian inventor, Alessandro Volta.

The Mayor of Camnago, Signor Cavaliere Franchi Vincenzo, in spontaneous and graceful language, expressed in the name of the municipality which he represented, his pleasure at being able to welcome such a distinguished body of scientific men, and invited them to partake of light refreshments at his villa.

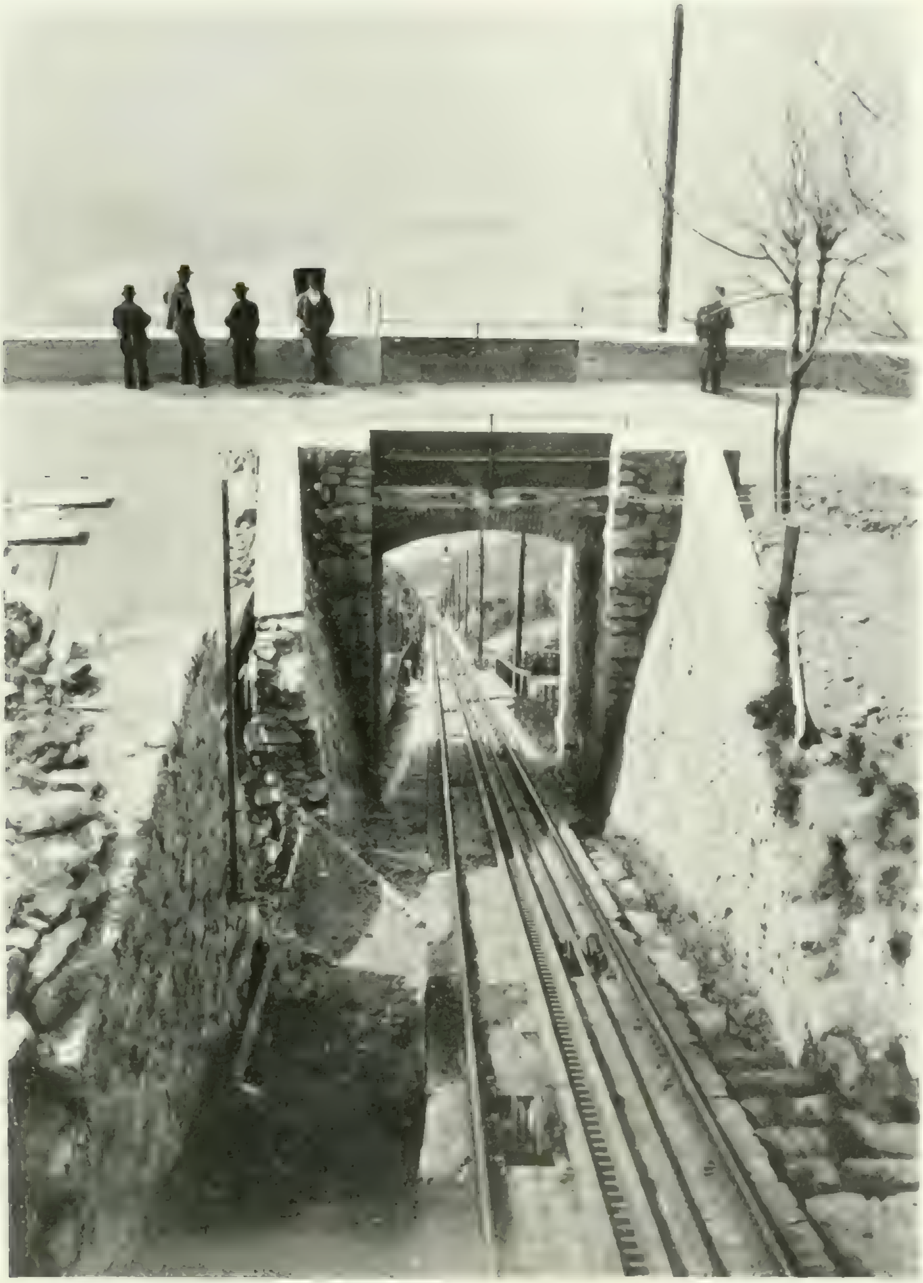
THE SECOND CARRIAGE LEAVING THE VILLA OF THE MAYOR OF CAMNAGO.
Mr. W. M. Mordey is seated on the left of Mrs. McMillan, Mr. W. G. McMillan (Secretary) facing

The Accident to Mr. C. J. Hall, of Leeds. Upon the return journey to Como a regrettable accident occurred, which might have been very serious. In descending a steep hill the brake of one of the large vehicles broke, and the driver to avoid being precipitated over an incline pulled across the road, when the conveyance partially overturned against a wall. To save his head from being crushed, Mr. C. J. Hall, of Leeds, put out his hand, and had his right arm caught between the vehicle and a rock and broken above the elbow. Two doctors were immediately in attendance, the arm was skilfully set, and Mr. Hall, pluckily declining to be made an invalid, proceeded to Milan the following day. He was unable, however, to accompany the party on any of the various excursions. According to the latest reports he is making favourable progress towards recovery, although it will be several weeks before he will regain the use of his arm.

The majority of the members, travelling by the funicular railway, had lunch at the Châlet Restaurant on the summit of Brunate. Although towards the close of the meal a sharp hailstorm intervened, the time passed very quickly in the glorious sunshine, with the panorama of the lake and town spread out below, and the Alps with snow-capped Mount Rosa towering above all, in the distance.

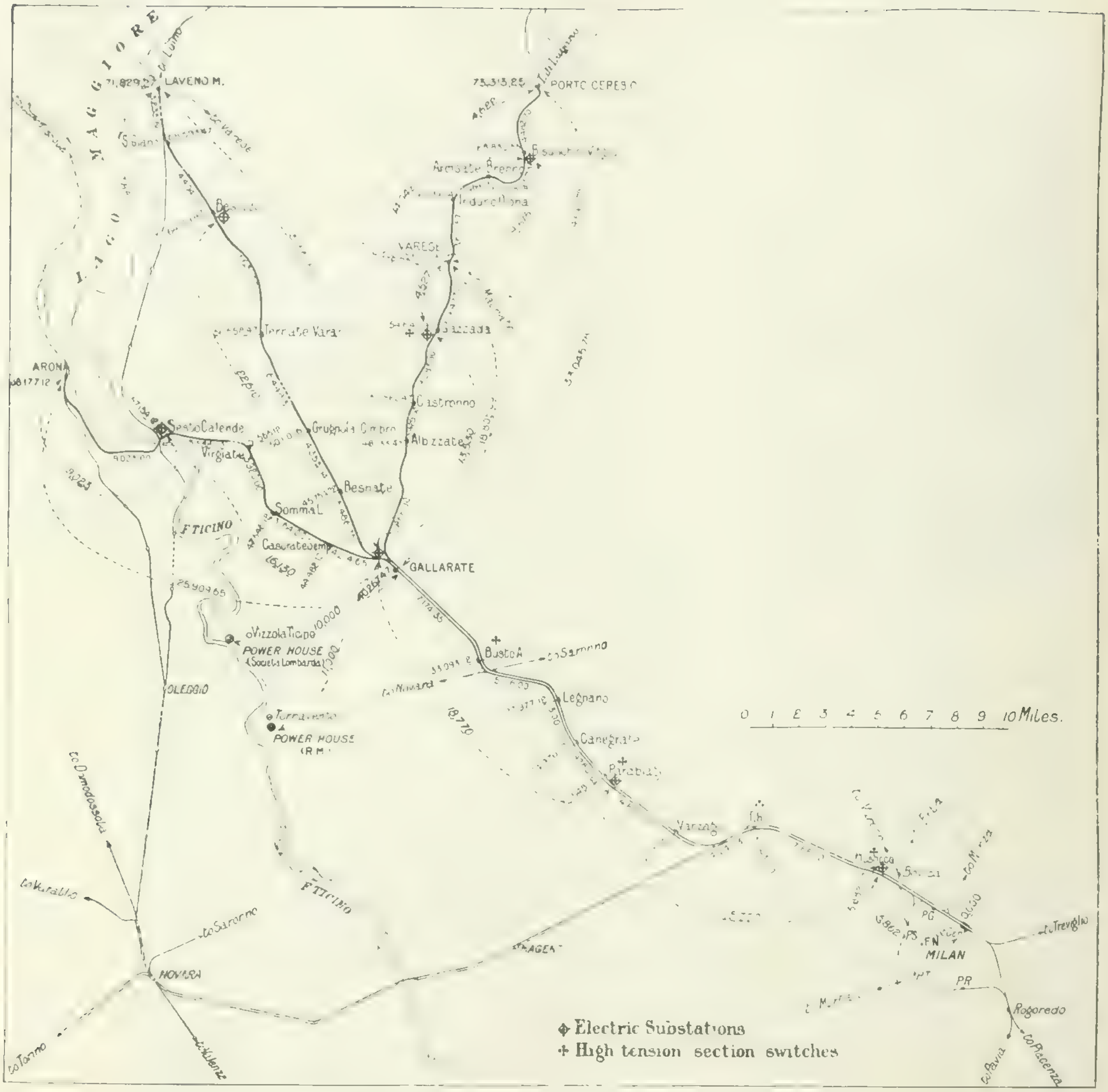
During the afternoon the Mayor gave a garden party in the Civic Museum, when the members of the party had an opportunity of meeting all that was best in Comese society. After a visit to the museum containing the papers and apparatus that belonged to Volta, tea and other refreshments were served, complimentary speeches were made, the National Anthem and the Italian Royal March were played, and everybody carried away the most pleasant recollections of the affability and cordiality of our hosts.

In the evening the Philharmonic Society gave, as a mark of their esteem, a concert in the gardens of the Hotel Plinius, which was largely attended by the general public, while the band of the 78th Regiment of Infantry played in the public square before the Hotels Volta and Metropole.



THE FUNICULAR RAILWAY AT BRUNATE, WITH LAKE COMO IN THE DISTANCE.

On Sunday afternoon the party ascended this railway, and had lunch in the open air at an elevation of about 2,500 feet, at the Châlet Restaurant, Brunate.



◆ Electric Substations
+ High tension section switches

FIG. 4. MAP OF THE MILAN-VARESE ELECTRIC RAILWAY.

Electrical Engineers' Visit to Italy.

MONDAY, APRIL 6th.

Everyone had to rise in exceptionally good time on the following morning (Monday), as the special train, kindly provided by the Mediterranean Railway Company, left at 7.50 a.m. As a matter of fact, it was whistled off four times, but had to be called back to pick up late arrivals, some of whom came straggling in, finishing the remainder of their first *déjeuner*. The programme for the day was a lengthy one, and proved almost too much for several of the party, who were very fatigued when they returned to their hotels in the evening. On arrival at Milan a special electric train was waiting to convey the party to Porto Ceresio and Varese.

The Milan-Varese Electric Railway. The Mediterranean Railway Company is equipping electrically the whole of the line from Milan to Gallarate, and thence to Varese, Porto Ceresio, Laveno, and Arona (see fig. 4). This railway is a good example of a line with a large traffic worked electrically on the third rail principle, which is the rival system to that of Valtellina. Its total length is eighty-one miles, and for the whole distance it is of single track, except the length from Milan to Gallarate, which is of double track. The section from Milan to Varese was opened for electric traction in November, 1901, and in June, 1902, it was extended to Porto Ceresio.

A high rate of speed was maintained by the train, occasionally averaging on the level a full sixty-five miles an hour. A short stop was made at Porto Ceresio, when everyone descended and had a brief stroll on the side of the beautiful Lake of Lugano. On the return journey a stop was made at Varese, where an excellent lunch was provided by the Mediterranean Railway Company and the Compagnie Thomson-Houston de la Mediterranée at the Grand Hotel.

Mr. Kossuth (son of the Hungarian patriot Louis Kossuth), Vice-President of the railway company, speaking in admirable English said, in welcoming the members of the Institution, that to have the two systems, viz., that adopted by his company and the one on the Valtellina line working on similar lines of railway and under somewhat similar conditions so close together, must be of great interest, but it would be unwise to decide upon their respective merits until these could be established by actual working results, which would in the course of a few years, be ascertained.

One of the directors of the Thomson-Houston Company from Paris also welcomed the party. Mr. Gray (the President), Lieut.-Col. Crompton, C.B., R.E., and Mr. Raworth, replied in suitable terms.

LIEUT.-COL. CROMPTON, C.B., R.E.
(PAST PRESIDENT).

The Power House at Tornavento. After lunch everyone settled down to a long drive of nine miles to the power house at Tornavento, over the most dusty road I have met outside of Mexico. Not being acquainted with all the facts which have influenced the company in selecting this site, one is somewhat disinclined to pass judgment upon their policy of building a steam power station, miles distant from anywhere. At present coal has to be carted to it, over the worst possible roads, from the nearest railway station, and is sent back again (as electric power) to the railway over transmission lines of about ten miles in length. The situation is partially explained by the fact that it was originally proposed that the station should be hydro-electric. Turbines of a total of 11,000 h.p. were to be erected and driven by water taken from

LIEUT.-COL. R. E. CROMPTON, C.B., R.E., AND MR. W. M. MADDEN (*smoking*) DISCUSSING A KNOTTY POINT.

the river Ticino, but serious difficulties arose in reference to the concessions of the water rights, which it is to be hoped will be ultimately adjusted.

The power is transmitted as three-phase current at 13,000 volts to five sub-stations along the line, where the pressure is reduced to 420 volts. It is transformed in rotary converters to direct current at 650 volts. From the sub-stations the current is taken to the insulated third rail.

The wires of all the lines are supported by porcelain insulators fixed to wooden poles 131 feet apart. On some sections, however, there is an iron pole every 32½ feet. The third rail is placed laterally to the track, and is supported at every 13 feet by artificial granite insulators on cast-iron foundation brackets, fixed to the sleepers. The rails are bound together by means of flexible copper connections having a section of 8 inches.

The motor cars weigh forty tons unloaded, and the trailers twenty-five tons, and can accommodate seventy-six passengers. Each motor car is driven by four 150 h.p. motors, each motor weighing 2·5 tons. The goods traffic is to be hauled by electric locomotives. Every electric car is provided with a hand brake and a compressed air brake, for which, and for the air necessary for the whistle, an electric compressor of 4 h.p. is placed under the frame. The current is taken from the third rail by means of four shoes placed at the four ends of each electric car. The shoes are supported by an iron angle fixed to the journal boxes of the trucks.

The drive back to Gallarate was equally dusty, and we were very glad to get on board the special electric train which brought us back in excellent time to Milan.

The Italian papers, in their accounts of the various visits, proved entertaining reading, of which the following is a typical extract from the *Milanese Post* :—

"The coldness and calmness of the English are so proverbial that it has awakened true astonishment to behold the admiration, indeed, we may well say enthusiasm, evinced by these gifted sons of Albion for our work. And it is with legitimate pride that we can verify this fact."

TUESDAY, APRIL 7th.

The Visit to Gavazzi's Electrically-driven Silk Works.

On Tuesday morning, the members of the Institution, accompanied by a number of Italian engineers, took train for Cernusco-Merate, where they were received by the usual band—a feature to which we were growing accustomed—the Mayor, and the representatives of Messrs. Gavazzi. A short walk brought us to the latter's splendid silk works, which employ about six hundred people—mostly women and children—and which are equipped throughout by electric motors. The place was beautifully clean and well lighted, which was due largely to the total absence of overhead shafting or belts.

There were 334 weaving machines in operation, each of which is independently driven by a ¼-h.p. motor. One of the principal reasons for employing single motors below the level of the work, is the absence of the risk of oil dropping from overhead bearings on to the fabric which is being woven, an accident which occasionally happens with the older system of driving.

The party strolled through the quaint country town to an old-fashioned albergo in the Market Place, where a substantial lunch was provided by the Italian Edison Company. Among those present were the Mayor of Merate, Comm. Ferrari (representing the Italian Government), Assessor Mira (representing the Municipality of Milan), Senator G. Colombo (the President of the Company), Mr. Esterle (the general manager), Mr. Cini (of the Adriatic Company), Mr. C. E. L. Brown (of Brown Boveri), etc. The meal, which was taken in the open air, was a very enjoyable one, and was followed by a few speeches. The *Milanese Post*, in speaking of this event, said :—

"The beautiful air, the influence of the weather, and the sweet season, had even caused these English engineers to lose their customary coldness, and although it is not easy to awake their enthusiasm and sympathy, their speeches took a colouring and warmth that we really would not have expected."

The toast of the Institution of Electrical Engineers was given by Senator Colombo in an interesting speech, in which he recalled the days when he visited the Holborn Viaduct Electric Lighting Station to investigate the possibility of the City of Milan adopting electric light. Assessor Mira and Comm. Ferrari proposed the loyal toasts of both nationalities, to which Mr. Gray (the President), Mr. Fawcus and Mr. Hammond replied. The speech of Mr. Hammond, rendered in Italian with great vigour, excited much enthusiasm among our hosts.

Lunch over the party drove to the Paderno Viaduct, which was built a few years ago to carry a single track line belonging to the Meridionali Railway Company across the valley of the river Adda. The bridge, which has a total length, minus approaches, of 871 feet, appreciably shortened the distance between the provinces of Upper Lombardy and Venetia, with respect to the St. Gothard route. After viewing this, a descent was made to the point at which the intake to the Adda Canal commences, where many of the party closely inspected the work of building the new dam, which is now in progress.

The Paderno-Milan Power Line. It is of interest to remember that the steam electric generating station in Milan, established in 1883 by the Italian Edison Electrical Company,

THE VISIT TO SIGNOR GAVAZZI'S ELECTRICALLY DRIVEN SILK WORKS AT CERNUSCO-MERATE.
The party entering the gates.

was the first of its kind in Europe. In 1893 the Company opened to the public the first urban electric tramway line, and the Municipality of Milan, having in 1896 sanctioned the conversion of the whole of the urban lines to electric traction, they secured the concession. In order to provide for this new service, and for other applications of electric power, the Edison Company built a new central station at Porta Volta, Milan, and began the hydro-electric installation at Paderno, which was completed in 1898. About two-thirds of the power generated is sent to Milan, the distribution there consisting of :—

MR. W. P. J. FAWCUS, OF MANCHESTER.

(*a*) A three-phase current underground system, supplying energy for lighting and power.

(*b*) A continuous current underground system, supplying energy almost exclusively for lighting.

(*c*) A tramway system.

The Milan tramways at holiday times carry over 325,000 passengers, which represents 68 per cent. of the population. The cars circulating on the system average 293.

A very enjoyable two mile walk along the charming valley of the Adda by the side of the canal was made to the power house at Paderno. After this had been inspected the party were grouped together and a memorial tablet to the original designer of the scheme, Engineer Enrico Carli, which was placed in a prominent position on one of the walls, was unveiled. After a very pleasant drive to the Paderno railway station in the cool of the afternoon, the party travelled by special train to Milan.

WEDNESDAY, APRIL 8th.

Pirelli and Co.'s Cable Works.

Next day the programme consisted of visits to the leading electric manufacturing and supply establishments in Milan. Probably the greater portion of the party visited the cable and rubber works of Messrs. Pirelli and Co., which are the largest in Italy This firm practically enjoy a monopoly of the manufacture of submarine and electric light cables in that country, and have also a considerable export trade. The works cover about nine acres, and nearly 3,000 workpeople are employed. As the firm were one of the first companies outside of Great

MR. ROBERT HAMMOND, HON. TREASURER, DELIVERING A SPEECH.

[illegible]

[illegible] habitants turned out [illegible] elettricisti Inglesi."

Britain to take up the manufacture of cables, extensions have had to be made from time to time as they were required, which have necessarily interfered with the general symmetry of the establishment. An auxiliary company has recently been formed in Spain.

The Royal Technical Institute. Several members were attracted to the Royal Technical Institute, which is a handsome building, and well equipped with up-to-date apparatus. At the present time over five hundred students are studying there, whose ages range from eighteen to twenty-five. The Institute and the school for engineers annexed to it were founded by the Italian Government in 1863, to afford instruction in civil and industrial engineering, and also to educate civil architects, and professors of physical and natural sciences. Its annual expenditure amounts to £7,450, and is contributed by the Italian Government and by the province and municipality of Milan. Every student entering the Institute goes through a two years' preparatory course, after which he enters the department in which he intends specialising, where he spends three years. The average yearly number of diplomas conferred is about sixty.

Several special schools and laboratories are annexed to the Institute. They were founded and are maintained by private contributions. One of these is for the education of electrical engineers, and offers to the local industries all the means required for performing tests and

THE VISIT TO THE ELECTRIC GENERATING PLANT OF VIZZOLA.

experiments on electrical machines and apparatus. This is a very neat room, and well arranged. Most of the instruments are of British pattern, and many are of English manufacture. A laboratory of mechanics was erected in 1894, with the aid of the leading firms in Milan, for the special benefit of students in industrial engineering; also, by the aid of private contributions, a laboratory for the testing of materials has been at work since 1865, and is largely used by the railway companies, by architects and builders. Many interesting experiments were here seen in operation.

Next year two new institutions will be opened in the Royal Technical Institute, viz., a school and laboratory of electro-chemistry and a school and laboratory for foremen engaged in electrical work. His Majesty the King of Italy has given the ground from the garden of the Royal villa, which adjoins the Institute, and special buildings have now been erected.

Gadda and Co.'s Works (Electrical Machinery). A very interesting visit was paid to the amalgamated works of Messrs. Gadda and Co. and Messrs. Brioschi Finzi and Co. All the machinery was found to be thoroughly up to date, after the best American and European patterns. Two machine tools specially noticeable were the large vertical boring mill, and the horizontal boring and milling machine, both of which were from distinctly American designs, and built by local firms. Every machine tool is driven by a separate three-phase electric motor. The works are provided with a complete system of rail tracks, and also with several 15-ton electric overhead travelling cranes.

The testing department, in which every machine is tested before delivery, is much nearer perfection than is usually seen in this class of works. For this department a power of 500 h.p. is reserved. It is provided with a complete set of testing brakes, standard instruments, alternators and motors of various capacity, one transformer for testing the high tension machinery up to 52,000 volts, etc. The fitting and machine shops were well lighted, and the tool store showed signs of having been very carefully organised.

The Telephone Exchange. Only a comparatively small number of engineers visited the telephone exchange, which is now being modernised and brought into line with the latest methods. It is hoped that when completed an uninterrupted service will be secured, even in the event of a heavy snow fall. At the same time the dangers arising from the possible fall of the wires on to the overhead tramway lines have been eliminated. To obtain these results all the necessary wiring from sub-exchanges to the central exchange has been effected with underground cables, and a special air drying plant is also provided. The cables, which Messrs. Pirelli and Co. have supplied, are lead-covered and have paper insulation if they are to be laid in clay. Those which are intended to be placed in sand or coal tar, are covered with an extra iron band. The ringing of subscribers is made by means of a motor generator, which transforms the continuous current of the town's distribution into alternate current. The number of subscribers at present connected up to the central station is 3,500, and 75 girls work in turn at the multiple switchboard. The exchange is designed for an ultimate capacity of 10,000.

Riva Monneret and Co.'s Turbine Works. The firm of Riva Monneret and Co., whose rapid success is very largely due to its enterprise, makes a speciality of the manufacture of turbines of every description. The two types, however, for which there is the greatest demand at the present time are the Pelton wheel and the Francis type. The machinery in the shops was not quite up to date, although the work turned out is certainly first class. Indeed, the majority of the turbines seen in operation during the Institution's visit to Italy were of this firm's manufacture. The most notable feature of the works is perhaps the drawing office, which is exceptionally large, and has thirteen vertically suspended drawing boards of an ingenious pattern.

GETTING READY TO BE PHOTOGRAPHED AT THE VIZZOLA POWER HOUSE.

The Officine Meccaniche (Railway Locomotives and Carriages).

The Officine Meccaniche was formed by the consolidation of the firms of Miani Silvestri and Co. and A. Grondona Comi and Co. When fully occupied, the works employ about 3,000 hands, and have an annual producing capacity of 30 locomotives, 250 railway and tramway cars, 2,000 goods trucks, besides railway bridges, turntables, signals, etc. They also keep in repair on an average 1,600 railway trucks per year. I regret that lack of space prevents an adequate description.

The visits to the central station at Porta Volta, and the sub-station at S. Radagonda, gave everyone, in conjunction with the visit to Paderno, a clear idea of the general scheme of the electricity supply in Milan.

THURSDAY, APRIL 9th.

The party left early on Thursday morning by special electric train for Somma Lombarda, on a visit to the works of the Lombardy Power Distribution Company at Vizzola. Entrusting themselves to a multitude of old-fashioned vehicles, and blinded by the dust raised by the long procession, the party, after about a couple of miles drive, descended the steep bank of the river Ticino, to a point at which four large canal boats were waiting, gaily decorated with the English and Italian flags. To the accompaniment of stirring music the barges floated down the Villoresi Canal to the power house. On the way lunch was served through the hospitality of the Vizzola Company, and the usual toasts were given and responded to. Senator De Angeli, president of the company, welcomed the guests, and was replied to in French by Mr. Gray (the President).

Visit to the Lombardy Power Distribution Co. at Vizzola.

The Vizzola power scheme differs from other similar plants inasmuch as it is not intended to supply electric power to a large city or to a number of works grouped together, but transmits the power to many independent works and cotton mills situated at wide distances from one another.

Some years ago a good many cotton mills were established between the towns of Varese and Saronno and the river Ticino, to utilise the natural power derived from the water of the river Olona, which, however, soon became insufficient through the rapid increase of these and other industrial enterprises. Many steam plants were then worked separately, or in conjunction with turbines, the area of the manufacturing district in the meantime extending widely. As soon as the problem of long distance transmission of power had been practically solved, it became possible to utilise the water power of the river Ticino, which could not be formerly done. The Societa Lombarda per Distribuzione di Energia Elettrica (to give them the Italian title) was then formed for this purpose, and took up the enterprise in 1901.

Current is now being distributed among 2,400 customers, who employ it for power and lighting purposes, and is transmitted as far north as Varese—22 miles, as far south as Turbigo—9½ miles, and to the east as far as Lomazzo—25 miles. It is very interesting to hear that in nearly all the cotton mills the steam plants have now been replaced by electric motors. So great has been the demand for power that the 18,000 h.p. generated at the central station at Vizzola is now insufficient, and the Lombardy Power Distribution Company have recently commenced the construction of new hydraulic works for the utilisation of another fall they possess at Turbigo, 9½ miles lower down the river. These works will give a further 6,000 h.p., which will be transmitted through the present distribution lines. To provide against periods of low water the company are also erecting at Castellanza a steam generating electrical station, where another 6,000 h.p. will be developed, making altogether a possible total of 30,000 h.p.

The thirteen mile drive to Legnano lay over a flat barren moor, and proves one of the most enjoyable of the trip. Upon arrival there, the electrically-driven cotton mill of Frua and Banfi, and the engineering works of Franco Tosi, were inspected. The former consumes 2,500 h.p. from Vizzola.

In the evening the Institution of Electrical Engineers were entertained at a banquet given by the members of the Associazione Elettrotecnica Italiana, at the Savini Restaurant, Milan. Covers were laid for about 250. Speeches were made by Mr. Ascoli, the President of the Italian Institute, Mr. Gray (the President), Lieut.-Colonel Crompton, C.B., R.E., Mr. Ferranti, Mr. Gavey and Professor Silvanus P. Thompson.

An interesting feature of the evening was a presentation to Mr. Semenza, of a cigar and cigarette case, which had been subscribed for by the members of the party to show their appreciation of the thorough way in which the arrangements for the visit had been made in Milan. The assembly broke up with the singing of "Auld Lang Syne," everyone clasping hands, which was evidently new to our Italian hosts, who entered into the spirit of it, with great heartiness.

ONE OF THE FINEST WEIRS IN THE WORLD, ON THE RIVER TICINO, NEAR SOMMA LOMBARDO.

The feature of this dam (951 ft. long, 13 ft. high) is the curve which seems to have been constructed to imitate the natural flow which water takes when falling in a large volume.

(Visit to Vizzola Power House.)

On the following morning the official visit came to an end, and a large contingent of the engineers proceeded to Venice to spend a few days there. Others preferred Florence or the Italian lakes, and many commenced to return by easy stages to London. On every hand there was a general concensus of opinion that our Italian hosts could not have been kinder or more hospitable, nor could our welcome have been more hearty or more spontaneous. The additional fact that it was animated by absolutely disinterested motives made the pleasure of receiving the hospitality all the keener. Any information that was asked for was always willingly given, and it was with great regret that we turned our faces homewards.

The preliminary preparations made by the Institution in organising the visit were of a most complete character, and everything which forethought and experience could suggest to make the tour enjoyable and comfortable had been carefully arranged beforehand. The success of this very important part of the programme was very largely due to the energy and painstaking care of our Secretary, Mr. W. G. McMillan. An elaborate set of labels covering the trip made that very irritating inconvenience—the losing or delaying of one's luggage—well nigh an impossibility.

MR. HENRY A. MAVOR (CHAIRMAN OF GLASGOW LOCAL SECTION).

List of Members forming the Party.

The following is a list of those forming the party:—

[illegible] brooke (London), H. Alabaster (London), A. H. Allen (London), R. S. Allen (Bedford), H. G. Andrews (Bournemouth), L. Andrews (Hastings), F. B. Aspinall (London), A. F. T. Atchison (Englefield Green), C. A. Baker (London), R. S. Ball (London), C. H. W. Biggs (London), H. Boot (Tunbridge Wells), H. Borns (London), A. von Boschan (Vienna), W. A. Brodie (San Remo), R. E. Brooke (Rugby), F. T. Callis (Sheffield), Jas. Connolly (Manchester), J. T. Connolly (Manchester), A. T. Cooper (Reading), W. R. Cooper (London), Lieut.-Col. R. E. Crompton (London), P. Dawson (London), J. R. Dick (Brighton), W. Dixon (Glasgow), S. Dobson (London), W. H. Donner (London), J. Eck (London), Prof. J. Epstein (Frankfort), R. Erskine (London), W. B. Esson (London), A. Fawcus (Altrincham), D. Fawcus (Altrincham), W. P. J. Fawcus (Manchester), T. J. Feilden (London), S. Z. de Ferranti (London), H. W. Firth (Chingford), A. Foyster (Edinburgh), J. Gavey (London), W. Geipel (London), Prof. E. Gerard (Liege), R. Kaye Gray (London),

MR. W. G. McMILLAN (SECRETARY).

F. A. Greene (London), C. J. Hall (Leeds), R. Hammond (London), W. E. Hardy (London), W. Harling (Dewsbury), J. R. Hewett (London), G. Hill (Ashton-on-Mersey), Col. H. C. L. Holden (Woolwich), F. J. Howitt (Bowden), F. H. Jackson (London), H. Jackson (Norwich), J. W. Jacomb-Hood (London), C. H. McCarthy Jones (Athens), E. M. Lacey (London), F. W. Lacey (Bournemouth), G. W. Lowcock (Manchester), J. R. P. Lunn (Darlington), Prof. M. Maclean (Glasgow), W. G. McMillan (London), W. M. Madden (London), E. M. Martin (Hyde), R. B. Matthews (London), H. A. Mavor (Glasgow), G. F. Metzger (Manchester), H. W. Miller (London), W. M. Mordey (London), Dr. D. K. Morris (Birmingham), J. T. Morris (London), G. J. Morrison (London), H. D. Munro (Exeter), G. M. Neele (Cheshire), G. H. Nisbett (Liverpool), Davidge Page (London), W. C. Peebles (Edinburgh), Col. F. Pescetto (Genoa), R. S. Portheim (Edinburgh), J. S. Raworth (London), T. Rich (Karlsruhe), L. L. Robinson (London), O. F. A. Sandberg (Rugby), P. W. Sankey (London), G. M. Sawtelle (London), E. K. Scott (London), W. B. Scott (Manchester), R. E. Shawcross (London), O. Shiras (London), A. M. Sillar (London), J. C. Smail (Cork), H. Stansfield (Manchester), T. Stevens (London), C. Stewart (Bilston), C. Stirling (London), A. A. C. Swinton (London), R. Tervet (London), B. Thomas (Manchester), Prof. S. B. Thompson (London), J. H. Tonge (Preston), R. Tree (London), C. Turnbull (North Shields), A. J. Venables (London), C. T. Walrond (London), A. H. Walton (London), Prof. W. H. Watkinson (Glasgow), A. H. Weddell (Uddingston), H. B. W. Whitmee (London), D. Wilson (London), J. A. Windham (Gibraltar), S. M. J. Wolff (London), A. P. Wood (Manchester), C. H. C. Woodhouse (Bordighera), E. B. Woollan (Tunbridge Wells), J. H. Woolliscroft (Hawarden), W. Wyld (Doncaster), T. P. O. Yale (Blaenau Festiniog).

HIGH CAPACITY WAGONS.

ONE WHO DOES NOT BELIEVE IN THEM.

A CORRESPONDENT who is a leading engineer of one of the British railway companies, sends us an interesting criticism on the High Capacity Wagons, of which we have heard so much lately. He says:—

"If constructed solely for the conveyance of loco coal, or to carry coke, iron ore, or pig iron to depôts where consignments of thirty tons and upwards are required daily, these wagons will no doubt effect a saving in the haulage. As, however, they cannot be used for shipping purposes, there being no plant at any of the ports, except two, in this country where these wagons can be handled, the question arises—will it pay dock companies to abandon the present appliances and put down plant capable of dealing with this class of wagon? I think not.

"Then, again, they cannot be used by the coal merchants, or by the colliery companies for conveying coals for sale in this country except to such places as London or other large centres where there are drops or pits below the rail level for receiving the contents of the wagon. Even these would be of little use with thirty-ton wagons having bogies at each end, as there could only be bottom doors between the bogies, and this would necessitate at least twenty tons of the contents being thrown out with the shovel. On the other hand, if the wagons are hoppered at the ends, the sides and ends would be required to be built higher, which would necessitate the colliery screens being raised to admit of the wagons passing under them.

"In view of the fact that goods wagons are often loaded with less than ten tons of merchandise, I think it will be at once admitted that these large wagons are of no use for goods traffic. It is stated that they could not be run on express goods trains, as wagons carrying more than ten tons are to be conveyed by trains not running at more than twenty miles per hour.

"Again, should a train consisting of this class of wagon be in a collision, and they jump the metals, their contents would have to be transferred into other wagons before anything could be done in the way of replacing them on the rails. If damaged to such an extent as to render it unsafe to run them on their own wheels, the main line would be blocked up for a considerable length of time, and much difficulty would be experienced in getting the class of wagon suitable to load these thirty-ton wagons upon. There is also the enormous cost of repairs which may be required after the collision, probably in some cases it would be cheaper to condemn the wagon rather than repair it. The cost of wear and tear has also to be considered, and as the Railway Companies are without the suitable plant for building or repairing this class of wagon at the present time, the cost would be enormous.

"Further, the thirty-ton wagons are not safe to be loose-shunted, so that considerable delay will be occasioned in shunting operations.

"There are no wagons better suited for use in this country than the present oak underframe and deal body wagons. These can be built to carry either ten, twelve or fifteen tons. They cost less to build, and less to maintain, and are also more easily and quickly repaired.

"Some of the wagons running at the present time and carrying eight and ten tons are more than twenty-five years old. They are still good wagons, and I question if these thirty-ton wagons will be found to run so long, even if they never come into a collision. The Talbott self-discharging wagon I have not seen, but I understand that it is only intended to carry ore, etc."

FIRST AID TO THE INJURED IN MINING.*

BY

DR. G. W. KING.

After an accident the danger to be apprehended to those who are severely injured depends in a measure upon the length of time which must elapse before medical aid can reach them. This period varies from a few moments to several hours, according to circumstances. During this interval of waiting what is to be done? In some instances nothing; in others prompt action must be taken to save life. The paper indicates the nature of this action in a number of specified contingencies.—ED.

THE causes of mining accidents are too numerous and varied to permit of a distinct classification. Those most constantly operative are falls from roof and sides, use of explosives, foul gases, operation of hoisting and traction machinery, explosion of inflammable gases (coal mines), traversing ladder-ways, placing of timbers. Under the term "miscellaneous" may be grouped all others which contribute in any degree to the production of accidents. While many accidents, from the nature of things, are unforeseen and unavoidable, it is to be regretted that a certain percentage, far too great, is due to either carelessness or disobedience of the rules established for the protection of all, including those who habitually transgress them. It seems almost incredible that men should persist in dangerous and forbidden practices which imperil the lives of others as well as their own, merely to save time or avoid a little additional work, yet this is often done with no apparent concern as to what may happen in consequence. This indifference to danger is perhaps not intentional; constant exposure without injury begets a disposition to underrate the liability of accidents and the necessity of guarding against them. This fact, however, does not excuse one who commits a rash act or who by negligence sacrifices the lives of his fellow-workmen instead of contributing his share to their preservation by more careful attention to duty.

The most reliable guarantee of safety must be based upon the practical knowledge possessed by the miner himself. He is expected to understand the nature of the ground in which he works, the proper manner of breaking it, the support required during and after the extraction of the ore, the precautions to be taken for the safe handling of explosives—in short, the whole procedure is in his hands, and the safety and efficiency of the work depends upon the skill and judgment exercised in its accomplishment. Self-protection is a matter of individual responsibility in so far as the immediate surroundings are concerned, and should be the first consideration in all that is undertaken. The conditions which pertain in mining differ materially from those that exist in ordinary labour above the surface of the ground. The miner, for instance, must work by the aid of a candle or safety lamp, and such light may prove inadequate for the close inspection of loose rock in the roof and sides of levels and stopes, and unless special care is taken dangerous indications may be overlooked even by a careful and competent observer.

These are some of the common and ever-recurring situations under which the work is done. Something more than the mere ability to perform manual labour is demanded; there must be skill to direct and govern every act; mistakes are perilous by the swift and destructive consequences which may follow. To become skilled as a miner an apprenticeship more exacting than that practised for the various trades must be accepted as the true method of training.

Looking a little further into the causes of mining accidents, we find an appreciable number chargeable to the use of explosives. The agent most generally employed is nitro-glycerine, known to the trade as dynamite or giant powder. This substance is reasonably safe at a moderate temperature and under ordinary atmospheric conditions, but is always to be regarded with suspicion, and few liberties should be taken with it, as no one can as yet determine the exact explosive point at any time or place, much less the influences which lead up to it, and induce a state of extreme sensitiveness which responds to the slightest jar or vibration. It possesses the disadvantage of readily congealing at a lowered temperature, necessitating the application of heat to expel the frost before using. This latter process is a source of real danger, and ought not to be trusted to inexperienced hands, or to any one for that matter, without the proper appliances for regulating the heat to safe limits. The method which gives the best security is that by which a moderate and uniform temperature is maintained, and the placing of a competent man in charge of the process whose duty it would be to supply the miners with powder and fuse upon requisition. Accidents which occur while charging the holes or from mistakes in length of fuse, neglect in signalling, defect in arranging facilities for retiring to a safe distance, are for the most part preventable, and the fault lies with the workmen themselves.

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* [illegible] Dr. G. W. King, Helena, Montana, at the Butte [illegible] Mining Congress.

The equipment of shafts operated by means of cages has been so well perfected that comparatively few accidents are noted if we take into account the amount of work done and the number of men transported to and from their work from month to year in the various mines that are in active operation. When an accident does occur in connection with the working of a shaft it is usually a serious one. The parting of a cable, the sudden giving of the brake upon the hoisting-engine, the failure of safety clutches, overwinding and precipitation of the cage to the bottom of a deep mine—any one of these unfortunate mischances must necessarily be attended with loss of life.

In sinking winzes and working shafts in the less pretentious mines, buckets are used to convey men and for general use in hoisting. The bucket when working without guys is not under absolute control, and when propelled at a high rate of speed assumes a rotary motion, which is apt to cause vertigo in some individuals to such a degree as to render them incapable of retaining their grasp upon the cable, as in one instance coming to the writer's notice—that of a miner falling from a bucket in making a descent of 200 ft. in a vertical shaft. No other cause could be assigned. Closing the eyes tightly will in a measure counteract the sensation of vertigo and prevent accident.

The speed should, however, be regulated within reasonable limits. The practice of riding upon a loaded bucket is unsafe and should never be done. Here is a case in point: Two miners were riding upon a bucket in which some pieces of lagging were being hoisted. Neglecting to lash the top of the poles securely, they came in collision with one of the timbers of the shaft; the cable was broken, and the bottom, with fatal results.

Other cases might be cited to prove that the [illegible] referred to is a dangerous one, but the fact [illegible] apparent to need further comment.

The handling of heavy timbers has its quota of mishaps, such as the breaking of ropes, slips, and sliding-ground risks that are usually unavoidable.

Machine-drilling in mines is not especially dangerous; the few accidents that come under observation happen while setting up the machine or from the giving-way of ground upon which it stands. Small particles of steel from the drill are liable to injure the eyes by becoming imbedded in the cornea. They are, however, readily extracted by applying cocaine and using a magnetised instrument of suitable size. If the foreign body penetrates into the interior of the eye the loss of that organ is a probable result.

Accidents met with in loading and coupling cars are usually of a minor class, and are in the majority of instances due to the want of care on the part of the workmen thus engaged.

Accidents from the inhalation of poisonous gases is a subject of special interest to miners, on account of their frequent exposure while working underground. The best-ventilated mines are not entirely free from this danger, and, as a consequence, miners are sometimes overcome by breathing gases collected or generated in stopes on recesses that cannot be wholly purified. Where good ventilation has not been provided, as in shafts and tunnels projected by prospectors, the danger is proportionally increased. The attempt to return too soon after blasting has occasioned loss of life. The introduction of compressed air as a motive power in the larger mines is of signal service in this particular. After blasting the air is turned on, and the obnoxious gases driven out before the men resume their labour. The candle test for unsafe air is observed by miners generally. They know that an atmosphere too poor in oxygen to support the flame of a candle is unfit to breathe, and precaution must be taken to avoid such localities when it is possible to do so. They should also understand that this test is not infallible. There may be, and often is, an admixture of gases capable of supporting the flame from a candle and yet deadly when inhaled. Experienced miners cannot have failed to note the behaviour of the candle-flame under these conditions. It flares up with a pale-bluish light, due to the presence of a gas known as carbon-monoxide. It is one of the most poisonous gases with which the miners come in contact. A product of imperfect combustion, it is generated by the detonation of explosive compounds, and, being colourless, odourless, and tasteless, its presence is only made apparent by certain symptoms produced by its poisonous action when introduced into the blood by continuous inhalation.

Associated with the ordinary carbon-dioxide which infests mines in as small a proportion as one per cent. it may prove injurious. A combination of the two gases seems to increase the toxicity of each other.

Carbon-dioxide is fortunately less active than the monoxide; moreover, it has a slight taste and odour, and can therefore be more readily detected. The two gases are generally associated together, and the chief concern is to be able to determine when their percentage in the atmosphere has passed beyond the limit of safety.

It is true that a difference exists among individuals in regard to their susceptibility to the action of these gases. One may be overcome in a place where another suffers but slight inconvenience. This fact often encourages the latter to take unnecessary chances. Men of experience and judgment, however, rarely go into a place where the air is known to be bad without being prepared to retreat promptly upon the first indication of danger. What these indications are should be as familiar to the trammer as to the miner himself, for it is among the former class that accidents from inhalation of foul air is most liable to occur. Their work necessitates the handling of loose earth, which is more or less permeated by the gas, which is easily freed by the disturbance and becomes mixed with the air they breathe. Poisoning by carbon-dioxide is at the time so insidious that the warning symptoms are unnoticed until too late to escape.

Symptoms of poisoning by carbon-dioxide.—The smell and taste of the gas is usually quite perceptible, and this indicates its presence when the percentage is small. Nothing more than a dryness of the throat and a slight headache may be experienced. In large amounts the headache becomes more intense; a peculiar throbbing pain is felt over the brow and back of the head. Vertigo supervenes, and the sight becomes dim and the limbs weak. There is a nausea and vomiting. An uncontrollable desire to sleep comes on, and the person falls never to rise, unless carried out immediately. In an atmosphere completely saturated with carbon-dioxide these progressive symptoms are not noted, for the reason that all is over in a very few moments.

The result is practically the same as being submerged in water. To rescue those who are insensible a systematic plan of relief should be adopted. To rush in excitedly only complicates the work, very likely adding to the number of already disabled. Form a relay of men and instruct the one who is to enter to apply a sponge or handkerchief saturated with water, or preferably with vinegar, over the mouth and nostrils. He must go quickly forward, take hold of the one insensible and drag him to the entrance as far as he can with safety to himself, then retire and give place to the one who stands ready to succeed him. This will render the rescue work less hazardous to all concerned. Operating in a shaft is more difficult and dangerous. When the descent is made by a bucket for any considerable distance through a poisoned atmosphere it is impossible to stand erect within it and maintain an equilibrium after the paralysing effects of the gas is experienced. A sitting or kneeling posture should therefore be assumed to avoid the possibility of being precipitated from the bucket. Should descent by ladder-way be undertaken, a rope fastened about the waist and manned from above is recommended as a wise precaution. A second rope may be lowered, if necessary, and made fast to the person to be brought up by means of a loop drawn snugly around the body close under the arms. The act of hoisting an unconscious person by the aid of a rope must be conducted with reasonable care; the tension ought to be steady, lest too forcible contact with jutting timbers or rocks should result in serious injury.

The treatment of asphyxia produced by inhalation of poisonous gases will be referred to in appropriate connection.

The prevention of mining accidents has been the subject of much study, and investigation is continually being made by engineers and practical mining men. Legislatures have also endeavoured to surround the miners with additional safeguards by legal enactments. Improvement has certainly been made, and with the advent of electricity for the purpose of lighting and motive power, further progress will be made evident in the equipments of mines that are to be operated in the future.

Were it possible to exclude the accidents which are clearly preventable, the occupation of mining would be less hazardous and the mortality lessened, a result most helpful and worth striving for, since at best there will be fatalities enough and to spare.

Taking the practical view, then, that with the best equipment and most efficient service, accidents may and do happen, the care of the injured must be considered with reference to their immediate necessities. To be prepared for emergencies is the first essential. This refers to the few medicines and appliances that may be needed for temporary use. These articles should be kept in reserve at the most accessible station within the mine, and plain and concise directions for their proper and legitimate use posted in a conspicuous place, that all may learn how and what to do for others in case of need. To avoid unnecessary complications the list of articles must be limited to the actual requirements, enumerated, it would appear, as follows: One half-dozen bandages, 2½ in. to 3 in. in width and 1 yard in length; one package of absorbent cotton; one roll of adhesive plaster; one dozen safety-pins; galvanised wash-bowl, soap, and towel; temporary splints for the limbs; a litter; one cylinder of compressed oxygen gas, with inhaling mask; medicines other than stimulants are not indicated. Two ounces of aromatic spirits of ammonia, with a small flask of brandy, are added for the latter. The medicines and dressings may be stored in a tin box with a tightly-fitting cover, and the whole protected from moisture.

After an accident the danger to be apprehended to those who are severely injured depends in a measure upon the length of time which must elapse before medical aid can reach them. This period varies from a few moments to several hours, according to circumstances. During this interval of waiting what is to be done? In some instances nothing; in others prompt action must be taken to save life. Upon those who are present or first to arrive devolves the duty of attending to the immediate necessities whatever they may be, as best they can. The demoralising effect of an accident upon those who witnessed it is apt to be harmful in two ways—First, by causing delay when time is the important factor; second, by inciting too energetic attempts at rendering assistance. It is therefore well to remember that, however alarming the situation, calmness and presence of mind are all-important.

Undue excitement contributes to render the chances of succour less certain, if not impossible. One who is competent to do the right thing whenever and wherever such service is imperative exerts an influence most assuring and helpful to those in peril, and to those who must assist in their care. Gentleness without timidity is of inestimable value in this service under all conditions.

In caring for the injured there are certain things to do, applicable in all cases, and we therefore begin by placing the individual in a recumbent and easy position, and proceed to loosen the clothing about the neck and chest; and, if the patient is able to swallow, and there is no excessive bleeding, external or internal, from wounds or concussions, a moderate amount of whisky or aromatic spirits of ammonia may be given as a temporary stimulant. If stunned or unconscious, no attempt to give fluids by the mouth ought to be made, owing to the liability of their entering the windpipe and causing suffocation. Cold water may with advantage be sprinkled on the face to excite effort at breathing. Friction applied to the extremities, being careful to select those which are uninjured, is a healthy measure. Heat applied externally is indicated when the surface of the body is cold and the circulation feeble. When reaction has become established, the limbs should be examined one by one, and in the same careful manner the chest, abdomen, and head. In this way the injuries cannot fail to be noted. When there is dangerous hæmorrhage caused by wounds, and fainting from loss of blood ensues, appropriate means to control it must be employed promptly. To arrest bleeding, different methods are employed, all more or less mechanical. Pressure is the readiest and most effective means for the temporary control in urgent cases. To apply the fingers over the course of an artery and compress it sufficiently to shut off the current of blood requires but an instant, and this advantage in time is not to be overlooked, especially when a large vessel is wounded.

Troublesome bleeding from wounds in the palm of the hand is effectually checked by similar methods. Digital compression of the large arteries of the thigh is more difficult, owing to the big mass of muscles by which it is surrounded. Resort must be sought in more effective methods. The limb should be elevated, and a small firm pad placed over the artery; then a handkerchief or piece of rope is made to encircle the limb over the pad, a sharp stick introduced into the loop and twisted upon itself until the bleeding is effectually controlled.

Cold is an effective means of checking oozing from small arteries or veins. Ice, snow, or cold water is placed in contact with the bleeding surface. Heat is equally serviceable, and is applied by means of compressors dipped in hot water. In deep wounds, when the source of bleeding is obscure, and the condition of the patient critical, packing the wound with strips of gauze, or with absorbent cotton, is permissible. After removing blood-clots the gauze or cotton is forced into the bottom of the wound and the cavity filled, and a bandage firmly applied to the parts. In these manipulations absolute cleanliness is to be insisted upon to prevent infection. The hands of the operator should be thoroughly scrubbed with soap and water, and the dressings kept free from contamination with as much care as possible

Internal bleeding, induced by serious injuries, is, unfortunately, not amenable to active treatments, and we must content ourselves with insisting upon perfect quietude, administering cool drinks, and applying cold compresses over the affected region. These simple means may appear insignificant and of doubtful utility in the presence of grave conditions, and the temptation to do something more radical in the way of treatment is at times difficult to resist. A moment's reflection upon the indications to be met should establish the fact that the immoderate use of stimulants or active movements of the patient tend to deviate the object we have in veiw, viz., to favour the formation of a clot at the point of rupture of the artery or vein—Nature's method of arresting hæmorrhage. Fainting is a saving incident and may be so regarded, unless the weakness is progressive and the shock so profound as to threaten immediate death. In the latter emergency stimulation and warmth must be the treatment. It is to be understood that surgical skill is required to deal with such extreme cases.

The suggestions above outlined are for the benefit of those who are uninstructed in the treatment of severe injuries. First aid applies only to the temporary care of those who are disabled and helpless; with that its utility ceases. Some injuries disable without endangering life, as instanced in the case of fractures of the limbs. Here some support is needed to steady the fragments during transportation. The resuscitation of those who have been overcome and rendered unconscious by inhalation of poisonous gases is necessarily first-aid work. The question of how to accomplish this object must be considered.

Little can be done before removal to a location where the air is comparatively fresh. Then cold water dashed into the face and friction applied to the limbs will stimulate the resumption of breathing. Should it fail to do so, artificial respiration must be resorted to at once. It consists of forcing air into the lungs by imitating the natural act of breathing. The steps of the procedure are as follows: Place the patient upon his back with head and shoulders slightly elevated; loosen the clothing and cleanse the mouth and nostrils; pull the tongue forward and bring it out at the angle of the mouth, to remove all obstruction to the entrance of air. The operator then kneels at the head of the patient, and, reaching forward, grasps the arms near the elbows, carries them up in an extended position. This manœuvre creates a vacuum in the lungs, allowing air to enter. The arms are held in this position for two seconds, then carried downward and pressed firmly against the sides, forcing air from the lungs by compression. This to-and-fro movement is kept up at the rate of fourteen to fifteen per minute, until there is a return to natural breathing, usually shown by a voluntary gasp on the part of the patient. This is the most reliable of all methods for restoring suspended animation caused by inhaling carbon-dioxide. Air must be got into the lungs either by force or natural act of breathing, otherwise the case is hopeless. This is true for physiological reasons which cannot be discussed here ; suffice it to say that under normal conditions oxygen freely enters the blood by way of the lungs, and its presence there is essential to life. As soon, therefore, as the breathing becomes regular the inhalation of oxygen gas may be begun, and continued until the livid colour of the skin becomes less marked, and consciousness returns.

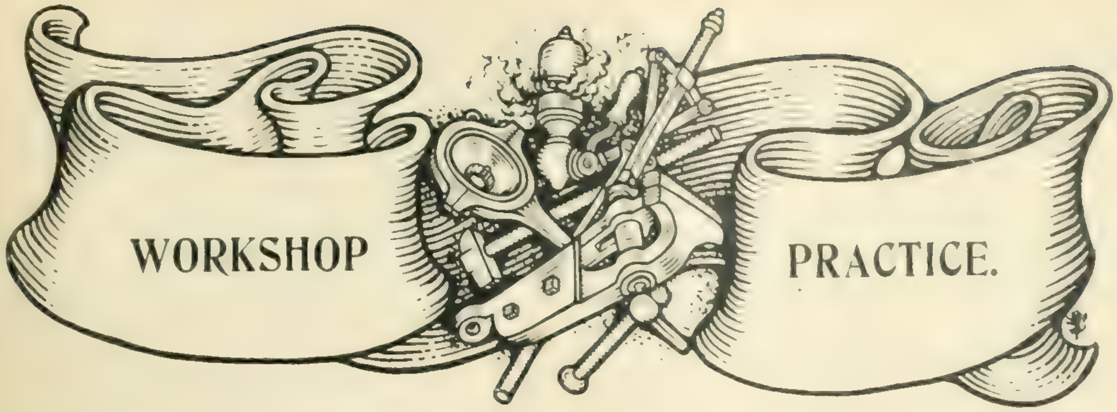
In the absence of the oxygen gas, stimulants are next to be thought of, as soon as there is ability to swallow. Whisky or aromatic spirits of ammonia are choice Ammonia has the property of quicker action, but less durable than that of alcohol. Sniffing the fumes of ammonia is also useful. When patients begin to revive there is apt to be cramping of the limbs, or general convulsions. This requires no treatment beyond protecting them from injuring themselves by the convulsive movements. The cases need watching for some hours, for it may happen that those who are apparently out of danger will suffer a relapse and become again unconscious and die if left to themselves.

The lifting and carrying of the injured is apt to be awkwardly done by men inexperienced in such service. Many injuries are of such a nature that misapplied force will further complicate the lesions which already exist, if, indeed, it does not lead to irreparable damage. A simple fracture of the leg may be converted into a compound one by injudicious handling. An unnecessary laceration of tissue is produced, and consequent suffering, besides adding to the gravity of the case. This is but one of the many things which may happen to the disadvantage of the patient during transportation. To lift an injured person properly requires three bearers. Two should stand upon opposite sides in a position to support the upper part of the body, the third where he can conveniently take care of the lower extremities. Then, with the patient upon his back, all drop upon one knee. The two principal bearers, pushing their arms under the back, lock hands firmly together. The third pushes both arms under the limbs. At a given signal all arise to their feet. The weight is thus so evenly distributed as to be easily borne, and there is no appreciable jar or sudden twisting of injured parts.

A litter devised by the writer is adapted for underground work, and insures safety in whatever position it may be placed. By its use in mining accidents the difficult problem of getting those severely injured to the surface without discomfort or danger is satisfactorily solved. The litter, with its burden, may be put upon a cage or in a bucket, and, when fastened in appropriate position, can be brought up without disturbing the position of the patient. To the litter a rope is attached to one end, and a guy line to the other, the latter being used to steady it during transit. When the upright position cannot be maintained—owing to syncope from loss of blood—a semi-horizontal or even reverse position may be chosen for the time being, in order to allow the remaining blood to gravitate towards the heart and brain—an expedient that is sometimes useful in extreme cases. The fastenings are so arranged that the position of the patient is not changed with reference to the litter while executing the different movements of hoisting or transporting through narrow passages, thus affording additional security and dispensing with an extra number of bearers. In practice this plan has proved to be an excellent one. The litter is inexpensive and durable. After being brought up to the surface the injured are given over to the care of a physician, or placed in an ambulance for conveyance to the hospital, and the duties pertaining to first aid are practically ended.

In rendering first aid to the injured simple methods are to be preferred ; they are always available, and, moreover, within the comprehension of any one possessed of ordinary intelligence, and can by them be easily put in practice at the time and place most urgently demanded.

Officious and meddlesome interference is to be avoided. It is never necessary, and may do harm. There are certain definite things to be done in sudden emergencies. Common-sense and prudence should indicate the course to pursue in every instance. The rule to do no harm is a good one, and should be kept in mind at all times. Its observance is never a cause of regret ; but, on the contrary, an evidence of a true desire to keep within the limits of safety—a most commendable qualification in the non-professional when called upon to take an active part in the care of the injured.



WORKSHOP PRACTICE.

A RÉSUMÉ OF MACHINE TOOLS, CRANES, AND FOUNDRY MATTERS FOR THE MONTH.

NEW TURRET LATHES.

THE Pratt and Whitney Company, of Hartford, Conn., have just brought out a new line of turret lathes that embody several very novel features. The object in view is to render them suitable for shops that do a general run of work, as well as for those handling specialities. They differ, therefore, in several of their details from the ordinary turret lathes.

In the first place the headstock, bed, and waste lubricant pan are cast in one piece. There is thus no risk of the head ever getting out of alignment, besides which, greater rigidity is secured, and the broad pan reinforces the bed without at all increasing the weight of metal. In the two smaller sizes, viz., ⅝-in. by 4½-in., and 1-in. by 10-in., the cone pulley is placed with its small step facing towards the turret, an arrangement which permits of a stiffer design of upright and spindle-bearing than the common design does. In the larger sizes, 1½-in. by 18-in. and 2-in. by 26-in., the large step of the pulley faces the turret.

The chuck arrangements are different in some of their details from the regular types. Thus, they embody provisions both for bar work and for holding thin flat pieces. One valuable feature is that the act of closing the collets or spring jaws does not in the slightest degree affect the longitudinal position of the work being gripped. The collet gripping mechanism for bars is shown in fig. 1, and that for flat pieces in fig. 2. These designs are similar, subject to the modifications due to the difference in the character of the two classes of work.

In fig. 1—the design for bars, passed through the hollow spindle—A is the collet, B a spring, C the ring that closes the collet, D a cap that is screwed on the end of the spindle E, F the plunger, and G a liner. In action, the advance of the plunger F thrusts C over the tapered end of the collet A, closing it upon the work. A slides down the face *a*, on the inner surface of the cap D, and these faces are ground to a mutual fit, and are tangential to a circle struck from the centre of the hole which encloses the spring B. The spring keeps the faces *a* in contact as long as the plunger F is in contact with C; but forces C back, allowing the collet to open, as soon as F is withdrawn. The object of the liner G is to ensure a proper alignment of the collet with the bearing. The faces *a* are kept in close contact by the spring, and thus preclude the possibility of dust getting into the mechanism or into the spindle.

In the chuck for flat pieces, fig. 2, the mechanism is similar, but the place of the collet is taken by a step chuck A, and closer. The chucks A are supplied blank, so that the users can bore them to any diameters required.

The provisions for regulating the length of bar to be cut off are hand-operated in the small machines. A modified style of Parkhurst wire feed is embodied in these. The feed sleeve is operated through a link, which is so connected as to give a feed to the rod double that for a given movement of the lever which can be obtained in the standard Parkhurst rod feed. A long feed can be thus obtained by one movement of the arm, instead of two, and as no power is lost, there is a clear gain obtained in the improved form. In the 2-in. by 26-in. lathe, a power roller feed is employed of a simple type, readily adjustable to cover a wide range of sizes in bars. In the turret itself several new features have been embodied that make for stiffness, accuracy, and ready means of adjustments.

The usual intermediate slide is omitted, the actual turret slide moving directly upon the bed of the lathe.

The alignment of tools should be absolutely ensured by this method. The strains are taken by one slide only, instead of two. The gibs are placed underneath, so that wear does not affect the alignment of the tools. The edges of the bed are bevelled in truncated vee fashion. The turret revolves about a heavy conical post or centre pin, secured in the turret slide, and bored through its upper portion to permit of long bars passing clear through the turret body. The large index rings are of hardened steel. Locking takes place under the tool in use. The locking bolt is nearly half as long as the turret slide, and wide enough to permit the post on which the turret revolves to pass through it. Its wear can be taken up with a taper gib on each side without removing the turret from the slide.

There are several other points of value in connection with the indexing, and the adjustments, the object of which is to prevent risk of error and of injury to the mechanism, but which could only be properly explained by the aid of diagrams. The stops are of a special design. They are all carried in a bracket at the front of the lathe, and are set one after the other by the lengths tooled on the trial pieces of work.

Perhaps the most striking feature of this lathe consists in the tool arrangements for use on the turret, for they are unlike any that have yet been employed. They include several designs for single, and multiple sets of tools for roughing, and finishing. The tool holders and steady rests appear like bosses sticking out from a plate fixed in one of the holes in the turret. Multiple tools have their holders further supported by a front plate. The arrangements allow of very rapid setting of tools, and of multiple cutting.

In one design, the roughing tools and their two opposed steady rests are each carried on a single plate fitted to the turret holes, and pierced with a central hole for the passage of bars. The roughing tool carrier pivots around a centre, and its radial position for diameter is set finely by a screw clamped in a curved slot hole. In a design for finishing tools, the latter have a direct radial adjustment only, with a screw behind. In designs for multiple tools, where either one or two supporting plates are employed to carry the tool holders and steady rests, each tool and its rests are separately adjustable, so that two or more shoulders can be turned on a single piece of work.

The lathe has a double cross slide for forming and cutting off tools, with adjustable stops. Either a lever feed through rack and pinion, or a screw feed with hand wheel can be employed at will. A novel feature of the tool posts is that the tools can be placed at any height or angle relatively to the work, and there

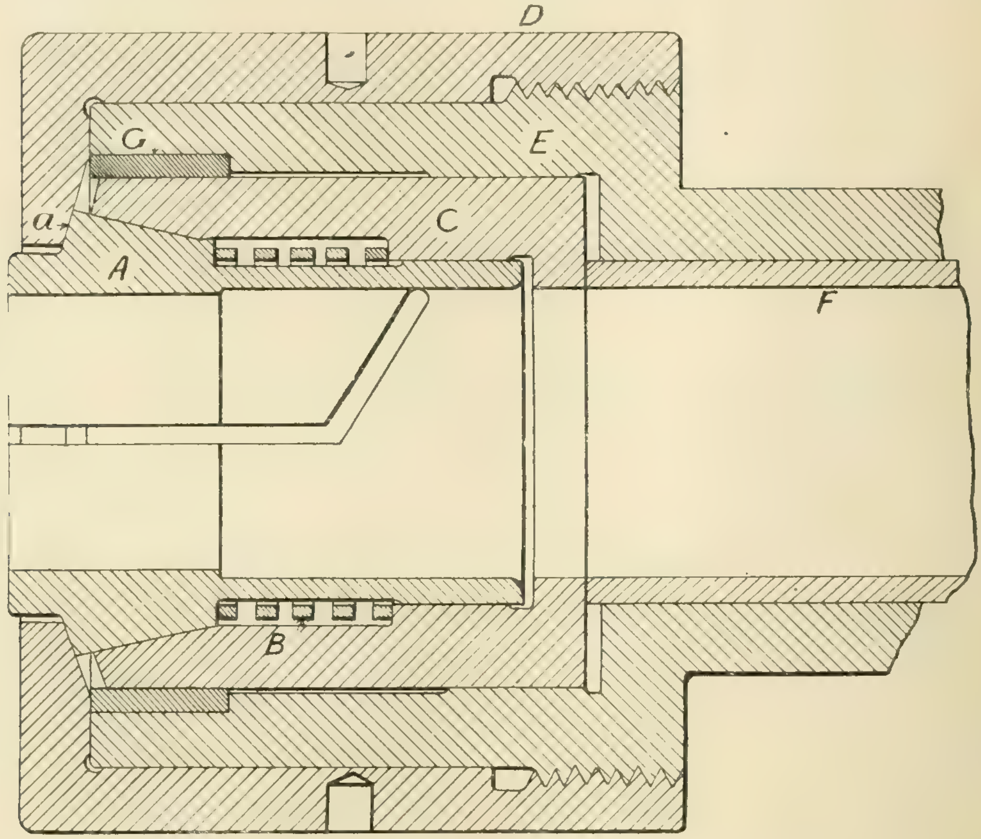


FIG. 1.

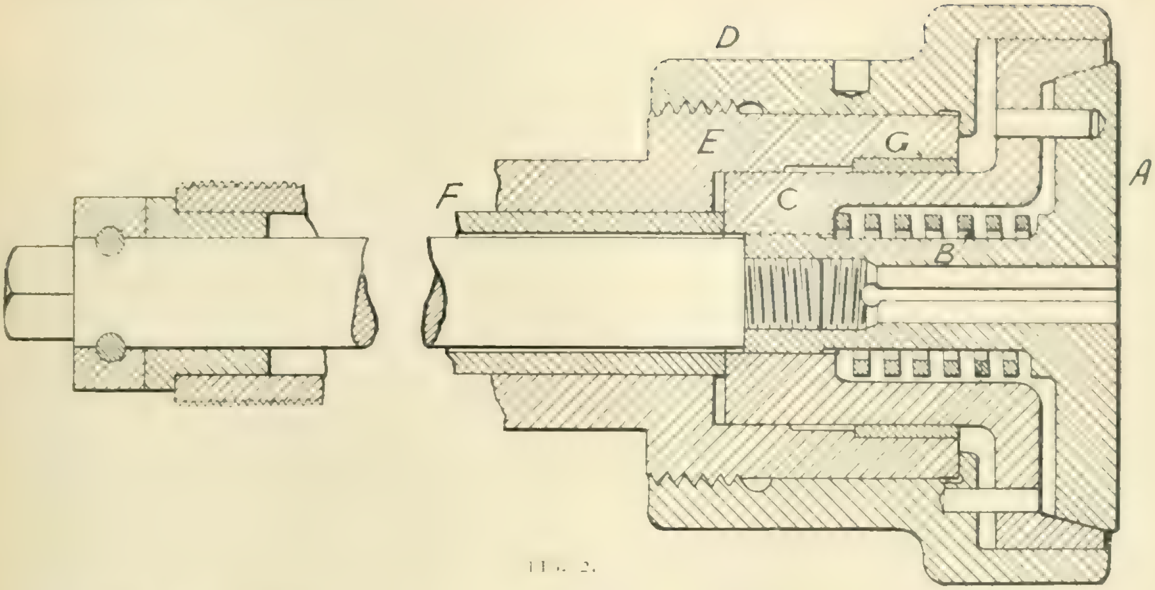


Fig. 2.

rapidly secured. This is accomplished by substituting two steps (A A, Fig. 3), one behind the other, for the usual solid support. These can be raised or lowered by their screws B to suit the height and angle of the tool, and the latter clamped by the pinching screws C above.

The Pratt and Whitney Company informs us that they are about to place on the market another large turret lathe of $3\frac{1}{2}$ in. by 36 in. capacity, the general construction of which will be practically identical with that of the 2-in. by 26-in. machine.

A HEAVY TURRET LATHE.

Another massive lathe has been introduced by an American firm, the Milwaukee Machine Tool Company. It has a $4\frac{1}{2}$ in. hole through its spindle, and weighs nearly five tons. The turret, though of hexagonal form, has three of its faces twice as long as the other three, the large and small faces alternating. The large faces are used specially for holding large sets of tools. The holes in its faces are 3 in. in diameter. The turret rotates on a raised circular vee of the same section as that used on American lathes. There is also a cross slide carrying a square turret for four tools. This slide can be run along underneath the face plate so permitting the main turret to be brought up close to face work. The main turret and the cross slide are operated each by its own separate feed screw, and each is driven through its nest of six gears underneath the head, so that operations can be carried on simultaneously with each. The gears are controlled by crank handles moving over quadrant plates, having holes for locking the various feeds. As there are six gears, six changes are obtained by a crank handle without touching the change wheels. By altering these latter a range of from $\frac{1}{64}$ in. to $\frac{1}{2}$ in. per revolution of spindle is obtainable, either for screw cutting, or for turning. Separate stops with automatic trips are fitted.

The lathe is built either for a motor drive or for belting from a countershaft. In the first design the motor is over the head, and is connected to the spindle by spur gears. The turret can travel to a length of 5 ft., the cross slide carriage 3 ft. A diameter of 28 in. can be carried over the bed.

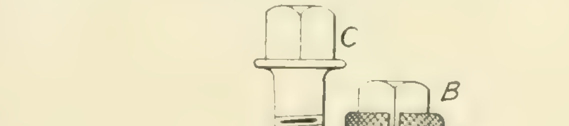


Fig. 3.

A NEW LATHE COPY SCREW DEVICE.

Applications of the time-saving turret continue to multiply. In addition to its use with the lathe it is fitted to vertical boring mills, drilling machines, milling machines, and moulding machines. In some instances again a supplementary turret is fitted on a main one. One of the latest adaptations of the turret is to the cutting of repetitive screws and studs, a familiar example being the screwed stays of locomotive fire boxes. These, when cut on brass finishers' lathes of the chasing type are done by the aid of a form screw rigged up at the rear of the headstock. A die nut, or comb piece engages with this, and being connected by a swinging rod to the chasing slide ensures the cutting of any number of screws exactly like the former without change wheels.

In the standard types of these lathes both copy screw and die, being single, have to be changed as often as screws of different pitches require to be cut, an operation which takes time. Messrs. Selig Sonnenthal and Co., of Queen Victoria Street, London, E.C., have introduced a device by which four copy screws of different pitches are carried on a single circular turret plate, which can be rotated into four different positions, corresponding with each screw. Another small turret on the swinging back shaft carries four die nuts, having pitches corresponding with the form screws, each of which can be brought round into contact with its screw. Only the copy screw which is in actual use is running.

The chasing slide is also fitted with a turret to carry four chasing tools, so that these have simply to be rotated—not changed. The lathe to which these are fitted is made in 7 in. and 8½ in. centres. The four pitches usually supplied are 11, 14, 19, and 28 threads per inch, but others may be substituted if desired. An ordinary turret is fitted, the headstock has a hollow spindle, the tailstock has its front ribs cut away, the bed is mounted on cabinet legs, and a tray is fitted between them underneath the bed.

THE PRACTICE OF CRANE MAKING.

In the practice of crane making, quiet and almost unobserved changes are going on which will become more evident a few years hence. Many new firms have been coming into the business, bringing new designs, and severe competition. Firms who introduce new designs can generally get high prices for their specialities, whether they are fully protected by patents or not. Those who offer old designs find everything so cut and dried that they often have to reduce their estimates to the vanishing point of profit.

Crane making, like machine tool manufacture, is passing through a period of transition, due to many causes. One is the introduction of electricity, which has modified many designs, and developed others that are practically new ones. Another is the greater value now set upon the economies obtainable by good methods of hoisting. Another is that specifications are frequently much more stringent than formerly with regard to the character of the workmanship, material, and tests of cranes. We recently heard of a specification in which the girders of an electric traveller of about 70-foot span were required not to deflect more than $\frac{3}{16}$ in. under the maximum load. In this case the firm who received the order took it for less than half the estimate of another competing firm, perhaps not fully realising the stringency of the specification, in which this was only one item.

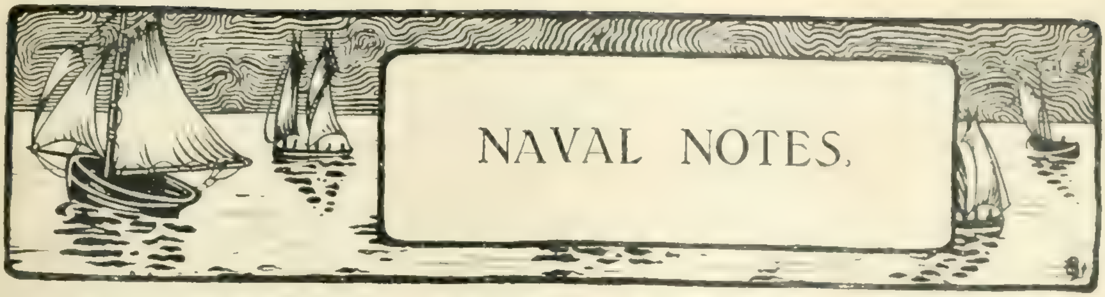
It is rather surprising in face of the many adaptations of electricity to crane work that the hand traveller appears to be made in larger numbers than ever. We know a firm that has on hand an order for twenty of these at the present time. And travellers of this kind are, after all, the cheapest for intermittent service—cheap in first cost, as well as in operation. An electric crane is costly, and requires to be in fairly constant service to be remunerative. The growth of power-houses and electric generating stations is one reason for the extended use of such travellers. They are required for the erection of the machinery before any current is available, and afterwards for intermittent service on repairs, etc., and they cost nothing beyond the interest on the capital expended. Here, as in other departments of practice, the due correlation of means to ends must be borne in mind as an economical principle.

MUSCLE *versus* MACHINERY.

The foundryman of middle age who reads the articles on the laying out of Engineers' Workshops will be reminded how "the old order changeth, giving place to the new." How much machinery has done, and is doing, to lighten the burden of labour in the foundry cannot be truly realised by the youth who is being brought up in a modern shop, amply equipped with tracks and tackle, conveniently arranged storage, moulding machines, good boxes, and the rest.

We question if there is any department where labour leakages are so serious an item as in the foundry. The money just runs away if muscle takes precedence of machinery. In this we are not thinking so much of the machines used in actual moulding, as of those unconsidered trifles that have to do with the handling of material and of work—tasks that are mostly performed by unskilled labourers. This includes carrying moulding boxes, or in the case of those of large dimensions drawing them along on trolleys, or even turning them over and over on their edges, tasks for which from two to six or eight labourers will be required; running in sand in barrows, and running castings out in the same manner. Tracks would avoid all this waste of muscle and time. In some archaic shops there are no means of loading up the cupola platform excepting by carrying bushels of coke up steps in baskets, and pig and scrap by hand.

Muscle has its legitimate place in foundries, but it is just doubtful whether that will not in time be reduced to a very small minimum.



NAVAL NOTES.

MONTHLY NOTES ON NAVAL PROGRESS IN CONSTRUCTION AND ARMAMENT.

BY

N. I. D.

LORD SELBORNE'S speech at the annual banquet of the Institute of Naval Architects has attracted naturally a good deal of attention. Recently the First Lord of the Admiralty has had a great deal to say about the *personnel* of the Navy, but on this occasion he turned to that other great division of naval force, the *matériel*. Particularly his lordship referred to the gigantic character of the revolution which has taken place in the modern man-of-war, and which is now to have its corollary in the revolution which will convert every seaman into a mechanic. It is a remarkable thing that although everyone acknowledges that a battleship must be a compromise, yet both in comparing one battleship with another, or in criticising any particular type, this fact is too often left out of consideration. Perhaps an equally remarkable fact is to be found in the practical unanimity with which all our foreign friends have followed the lead of Sir William White in regard to design. It is true that there is no finality in naval architecture, and it is quite certain that as Lord Selborne said, the future of the naval architect is at least as great as the past has been. We are only at the beginning of the solution of the problem which this science presents. The line which the First Lord of the Admiralty suggests to the naval architect of the future is one of achieving results equal to those now being achieved, but with greater economy of weight. Certainly there is much of promise in this direction. A great gain has already been made in regard to armament, something has been arrived at in regard to boilers and machinery, and it is likely that with a lighter gun we may get as good or better results than those now obtained with existing ordnance. The recent decision to standardise manufacture should also have its effect by reducing the articles now carried in duplicate and triplicate in every ship. Something may be hoped also from the turbine and something from liquid fuel. At all events, the naval architect who works in the field referred to by Lord Selborne should find at least something in his favour.

There is another direction though in which the naval architect can show his ingenuity with advantage to himself and to the State. In the old days of wooden ships their crews knew that though they might be beaten it was many chances against the vessel's foundering under them. To-day this is not the case, and thus has been removed one of the factors of confidence which must have had great effect. The naval architect, said Lord Selborne, who could find out how to build a ship so as to make her less vulnerable to the most mortal shot that she might encounter in war, so as to make her chances of flotation in action greater and her chances of sinking less, was the man to whom the future offered boundless opportunities.

Another subject to which the First Lord in his observations drew attention, was that of inventors and the aspect in which they were regarded by the Admiralty, and that in which they regarded that institution. Inventors, Lord Selborne tells us positively, pour their ideas upon the Admiralty, but out of every hundred suggestions thus made not more than one is new. As a rule the ideas are those which have already been examined and adopted, or more frequently discarded because demonstrated by experience and investigation to be unsound. Moreover, every inventor appears to think that it is the duty of the Admiralty to use the money of the nation in testing his ideas, and proving whether they are sound or not. The principle which guides them at the Admiralty, the First Lord asserted, was that it was far better to take up an idea for which there seemed to be good foundation, and to carry it forward even to eventual failure, than to run the risk of such a stupendous error as was once made in rejecting the idea of a breechloading gun, because of the difficulties that manifested themselves on the first presentment of the invention. "Let them remember," said Lord Selborne, "when they criticised the Admiralty for waste of money in connection with water-tube boilers; when they spoke as if the naval problem was the same as the mercantile problem, although it was perfectly different, and perfectly distinct; when they pointed to returns presented to Parliament to show how much money had been spent on repairing the water-tube boilers of the earliest ships of the type that were made in this country; that a far greater service had been done to the nation in experimenting, even at great cost to the taxpayer, with water-tube boilers, than would have been done had the invention been ignored and stifled, as was the case with the breechloading gun."

Turning to another matter of importance, I must mention the circular letter which has been issued on the subject of the new Admiralty scheme of naval training. The result, the first and great result, of the reorganisation of the training set forth in this circular will be to make every seaman a mechanic, just as the scheme in its working will make every officer an engineer. In other words, the crew of the ship must accommodate itself to its environment—the box of machinery. After October next every ordinary seaman, before he can qualify for the rating of A.B., will have to pass an examination showing that he has a knowledge of the use of simple tools, of the working of water-tight doors, sluices, fire mains, etc., and that he is generally proficient in the ordinary duties of the stokehold. Similarly and concurrently in the boys' training ships a new curriculum of study will be inaugurated, by which physical and mechanical training will be substituted for mast and sail drill, and such other drills as are not suited to the training of a seaman in a modern man-of-war. Right through this circular also runs plainly an indication of the intention of the Admiralty to counteract that inclination to the shore, which is such a feature of the new Navy. Secondly, there is an indication of an intention to widen the area of specialisation. While the lower ratings will spend more of their time at sea, those men who have attained to the higher and more specialised grades will have a larger attention paid them in the schools. Speaking widely, that system with which Mr. Yarrow's name is mentioned in connection with the training of engineers seems to be the one adopted by the Admiralty. A forenoon spent in the study, an afternoon spent in practical exemplification of the morning's teaching, is the principle adopted wherever it is possible. The keynote of the change is thoroughness in every detail.

In the same circular there is a significant notice in regard to the engineers as they exist at present. It is evidently intended that as soon as the lieutenants E. of the new scheme enter the Navy fusion will take place, and the titles now given with all other differences will disappear.

The selection of Professor James Alfred Ewing as the new Director of Naval Education is of excellent augury. Professor Ewing is well known to all engineers, and his qualifications for the post he is now to occupy are unquestionable. In addition to other special qualifications, he brings to his new position a knowledge of foreign countries and of foreign fleets. He is noted for his tact and courtesy and common sense, and while Cambridge will be reluctant to lose his services, he will be welcomed by the Navy, and have the full confidence of the country generally.

GREAT BRITAIN.

The battleships of the *Duncan* class have now made their trials, although they have not in every case been entirely successful. The *Russell*, which has been commissioned, made on her full power run 19·3 knots, with 18,229 i.h.p., the *Exmouth* which followed her made on her full power run 19·05 knots, with 18,346 h.p.; the *Montagu* underwent a special series of trials, and in a four-fifths power attained a speed of 17·8 knots as a mean of four hours, with a coal consumption of 1·78 lb. per i.h.p. per hour. On her full power trial she made 18·8 knots, with a collective i.h.p. of 18,285. Her experimental gun trials were also carried out with success, the whole of the armament being satisfactorily tested. The *Duncan*, on her full power trial, made a speed of 18·9 knots, with 18,232 i.h.p. The *Cornwallis* completed her trials in March, and in every way passed through them expeditiously and satisfactorily. She made a speed of 18·9 knots with a horse-power of 18,238. Comparing her with the *Montagu* as regards coal consumption in her four-fifths power trial, she attained a speed of 17·94 knots, as the mean of four hours with a coal consumption of 2·09 lb. per i.h.p. per hour. The *Albemarle*, on her full power trials, attained a speed of 18·6 knots, with 18,296 i.h.p.

Of the battleships of the *King Edward VII.* class, the *Commonwealth* may be ready to take the water, or even will have been launched, before these notes are in the hands of the readers. The *King Edward VII.* is to be launched on July 23rd.

Turning to armoured cruisers, the *King Alfred*, the last of the *Drake* class, has been reported ready for commission, and the *Good Hope* having returned from South Africa has been taken in hand with a view to improving her propellers.

The *Spartiate*, the last of the protected cruisers of large displacement, was commissioned for service on March 17th.

A number of small vessels have been put into the water. The *Clio*, sloop, was floated out of dock at Sheerness on March 14th, her keel plate having been laid on March 11th, 1902. The machinery of the *Clio* is to indicate 14,000 h.p., steam being supplied by boilers of the *Niclausse* type, and her anticipated speed is 13½ knots.

Three destroyers have been launched—the *Ettrick* from the Palmer yard on February 28th, the *Eden* from the yard of Hawthorn, Leslie and Co., on March 14th (this vessel is to be fitted with turbines and boilers of the modified Yarrow type), and the *Itchin*, launched from the yard of Messrs. Laird on March 17th. The *Velox* destroyer, fitted with turbines, did not, on her full power trials in March, give the most satisfactory results. The speed realised was 27·07 knots—steam being supplied by modified Yarrow boilers. The reciprocating engines supplied to the ship for cruising purposes gave a speed on trial of twelve hours of 11·26 knots, with a coal consumption of 8·68 cwt. per hour.

Torpedo-boat No. 111, which was launched by Messrs. Thornycroft in November last, has made her trials at Sheerness with 2,922 i.h.p.; she realised a speed of 28·43 knots, the contract requiring only 25 knots.

Submarine A2 has also been launched by Messrs. Vickers. She is rather larger than A1, and differs from that vessel in many minor details.

FRANCE.

The armoured cruiser *Jeanne d'Arc*, which has been used for the conveyance of the President to Algeria, made on her trials a speed for some hours of 19·4 knots. The *Admiral Guyden*, on a full power run, made 18·8 knots with 11,000 i.h.p. The trials at Brest of the first-class cruiser *Guichen*, which were interrupted by hot bearings, have now been completed, when on a run of two hours at full speed she attained a speed of 23 knots. The *Marseillaise*, which broke a propeller blade and sustained other damage while being towed to the dock, will be under repair for several months. The *Kleber* has commenced her preliminary trials and maintained a speed of 18 knots for five hours. The second-class cruiser *Jurien de la Graviere* has not yet attained the contract speed; with 17,461 i.h.p. she made 22·9 knots, the stipulated speed being 23 knots. The *Sully* in her preliminary trials made a speed of 20·4 knots. The *Desaix* has also been under trial.

The destroyer *Sagaie* has attained a speed on trial of 30·6 knots, and the *Sarabande* was launched at Rochefort on March 12th. The *Catapulte*, another destroyer, was launched on April 1st at Marseilles. This vessel is to have an estimated speed of 28 knots.

UNITED STATES.

All the ships of the latest programme are to be built by private contract. Of the two armoured cruisers of the previous programme the Cramps are to build the *Tennessee*, and the *Washington* will be built by the New York Shipbuilding Company. Two of the battleships now in hand should be completed shortly. These are the *Missouri*, building at Newport News, and the *Ohio* at the Union Ironworks, while the other vessels of this class, which are little more than a quarter advanced, are the *Virginia* at the Newport News Works, the *Nebraska* at the yard of Morand Brothers, the *Georgia* at the Bath Ironworks, and the *New Jersey* and *Rhode Island* at the yard of the Fore River Ship and Engine Company. The two last-mentioned are the most advanced of the five vessels. Work has already commenced on the *Connecticut* at the New York Navy Yard, and the *Louisiana* was laid down on February 1st at the yard of the Newport News Company.

Of the eight armoured cruisers in hand, the *West Virginia*, building by the Newport News Company, and the *Colorado*, building by Cramp and Sons, are the most forward. The two vessels next advanced are the *Maryland*, building by the Newport News Company, and the *Pennsylvania*, building by Cramp and Sons. Following these come the *South Dakota* and *California*, both building by the Union Ironworks.

The protected cruisers in hand stand in order of progress towards completion as follows:—the *Cleveland*, building by the Bath Ironworks, the *Denver* by Messrs. Neife and Levi, the *Des Moines* by the Fore River Ship and Engine Company, the *Chattanooga*, which was launched on March 14th at the Louis Nixon Yard, the *Galveston* by the W. R. Trigg Co., the *Tacoma* at the Union Ironworks, the *Charleston*, building by the Newport News Company, the *St. Louis* by Messrs. Neife and Levi, and the *Milwaukee*, which is being built at the Union Ironworks. All the other vessels in hand are in a very forward state.

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DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

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OUR MONTHLY RÉSUMÉ.

LONDON, April 20th, 1903.

Shipbuilding Costs and Wages.

The shipbuilding industry is being kept back by the rise in the price of shipbuilding material, which occurred, unfortunately, just after labour cost had been brought down by a general lowering of wages in the shipyards and engine shops. This reduction in wages was effected after prolonged negotiations, during which the men were brought to see with the employers that unless the costs of production could be materially lowered, there was no hope of sufficient renewal in the demand for new ships to keep the yards even moderately employed after existing contracts were worked off, and labour is the chief item in the cost of production of ships. The reduction in wages is practically five per cent., whether one counts it on piece-work or time rates, And the only real difficulty in arranging it occurred on the North-east coast of England, where the shipyard joiners and plumbers resisted, and the former went out on strike for five months rather than submit. They came to terms, however, last month. In the case of the engineers and machine workers, the matter was referred to a conference of the Executive Councils of the Employers' Federation and the Allied Trade Unions, who recommended acceptance of the reductions, but got the men a little longer time at the old rate. Unfortunately the effect of the reduction in costs thus effected has been neutralised by advances in ship plates and other material, resulting from the large advance in pig iron. Thus, the second quarter of the shipbuilding year does not begin under very happy auspices, or with brilliant prospects. And as there is not usually much contracting done during the summer months, we must now look forward to a quiet shipbuilding year. According to Lloyd's returns the vessels under construction at the beginning of the second quarter are 425 in number, and 974,686 in tonnage, comparing with 431 vessels and 1,240,344 tons at same time last year. These figures do not include warships.

Admiralty Contracts.

The Admiralty, however, are going to give out as much repair work as possible to the private yards. The work to be immediately given out to contract includes the repair of two battleships, a first-class cruiser, a second-class cruiser, and a gunboat; but as thirteen vessels are already on the list of the dockyards this contract list will have to be augmented. The battleships are the *Canopus* and the *Goliath*, both dockyard-built vessels, the former constructed at Portsmouth and the latter at Chatham. Much

Our Monthly Résumé.

of the work of repair is associated with machinery. The *Canopus* was engined by Messrs. Scott and Co., of Greenock, and the *Goliath* by Messrs. Penn and Co., whose works are now owned by the Thames Iron Works Company, London. The two cruisers were built by the Fairfield Company. They are the *Argonaut* and the *Highflyer*, and the gunboat is the *Magpie*, which was built several years ago at Pembroke. Then later on in the year the contracts for new vessels under the new Naval programme will be given out. Of course, these are matters that will affect only a few yards, but they will provide a large amount of employment.

The New Naval Base.

An important movement, both industrially and strategically, is that for the establishment of the new Naval base at St. Margaret's Hope, Scotland. Little time is to be lost on the work of preliminaries. Temporary arrangements for anchorages, repairing ships, coaling ships with Temperley transporters or other systems, etc., will be made; and work will be commenced within a year on the permanent docks for repairing operations on an extensive scale. The constructive work will extend over some years, embracing a large ship-repairing and store department, with extensive berthage or anchorage for ships in the reserve. It is not probable that new ships will be built at the Scotch Naval base. The argument used to be that it was necessary to order new ships from the dockyards to keep in constant employment a complete staff of officials and workers, thoroughly conversant with modern ideas. The facts that only two ships have this year been ordered from the Government Dockyards, and that only one large ship is to be laid down under the new programme during the next twelve months, are signs of the times. A battleship or a cruiser might be built in as short a time in the dockyards as in private works, but when vessels to refit or repair are urgent, men have to be withdrawn from new work to deal with them. Therefore, the new dockyard ship costs more, and is so delayed as to be often nearly obsolete before completion. It is not desirable to increase the employees of the dockyards, where men cannot readily be got, and where, when discharged, they cannot easily find other employment.

A Scotch Ship Canal.

One of the Scotch Members of Parliament, Mr. James Caldwell, has been pressing on the House of Commons the advantages of Scotland from a Naval point of view, and the desirability of a ship canal between the Clyde and the Forth. Scotland has excellent harbour accommodation both on the East and on the West coasts, and the Clyde, with its shipbuilding, its supply of workmen, and its proximity to the coal and iron fields, is pre-eminently suitable for a Government Dockyard. It was true, he admitted, that the new Naval base at St. Margaret's Hope on the Forth would to a large extent, if not entirely, mitigate the grievance so far as the East coast of Scotland was concerned. It would provide a Government Dockyard in proximity to the eastern coal and iron industries, and an excellent harbour for a fleet of any size watching and protecting the harbours and ports and shipping on the East coast, but under existing circumstances it would not help the harbour and shipping interests on the West of Scotland in the event of war. The whole complexion of the matter would be changed by the proposed ship canal between the Forth and the Clyde, which would enable ships of war to pass freely from one coast to the other. Such a canal would be only thirty miles in length, and would be capable of being traversed in from five to six hours. By its means the Naval base at St. Margaret's Hope on the East coast would be in direct water communication with a fleet operating on the West coast, and also in direct communication with the shipbuilding yards on the Clyde and in the North of Ireland. There would also be no chance of a fleet being hopelessly blockaded at St. Margaret's Hope—in fact, the importance of such a canal from a national defence point of view is obvious. The existing barge canal would be useless for the purposes of a ship canal, but it demonstrates the practicability of making a canal suitable for the Admiralty on similar lines to the present one.

Canada and Shipping.

The acquisition of the Beaver Line of steamers by the Canadian Pacific Railway Company is now complete. The company announces that the growing requirements of Canadian railway developments have rendered it necessary to provide a Transatlantic steamship service, and in giving effect to this policy the company has acquired a fleet of fourteen steamers, which have hitherto been running under the auspices of Messrs. Elder, Dempster and Co. These vessels are well known, and are admirably adapted for the Canadian trade, for which the majority of them have been specially built. With the opening of the St. Lawrence regular services between Liverpool, London, Bristol, and Canadian ports will be established. These steamers will be run in conjunction with the railway system, which includes a fleet of passenger and freight boats on the great inland lakes and rivers of North America, on the coast of British Columbia and Alaska, and the well-known Transpacific Empress Line, which provides communication between Vancouver, Japan and China. By extending their operations to the North Atlantic trade the Canadian Pacific Railway will be able to undertake the control and handling of goods bound to or from Europe *viâ* the Canadian Pacific Railway or steamship services. Following are the names and sizes of the steamships:—

CANADIAN PACIFIC RAILWAY ATLANTIC STEAMERS FLEET.

	[illegible]
Lake Manitoba	8,852
Lake Champlain	7,550
Lake Erie	7,750
Lake Michigan	7,000
Mount Temple	7,656
Milwaukee	7,319

	Gross ton.
Mount Royal	7,044
Montezuma	7,345
Montreal	6,870
Montfort	5,481
Mounteagle	5,467
Montcalm	5,466
Monterey	5,443
Montrose	5,431

In this connection we may note that henceforth saloon and second cabin return Cunard tickets are available for return from New York or Boston, or by the Allan Line steamers from Montreal or Quebec in the summer, or from St. John's, N.B., or Halifax during the winter. This means drastic competition with the Morgan Combine. Messrs. J. and A. Allan are making some important additions to their well-known Canadian fleet.

Shamrock III.

The accident to *Shamrock III.* may be said to have caused general consternation in yachting circles, which, however, were soon dissipated by Sir Thomas Lipton's emphatic statement as to his intentions. Something more than a sporting interest attaches to the new cup challenger. She was built at the historic yard of Messrs. W. Denny and Brothers, Dumbarton, to the designs of Mr. Fife, of Fairlie, the well-known yacht builder. In her construction the aim has been to combine strength with lightness. For the hull, nickel steel has been used, with better effect than in *Shamrock II.*, with manganese bronze. The deck is plated with aluminium and covered with canvas. The frames are bulbed angles of nickel steel, the angles lighter than in *Shamrock I.*, but spaced more closely together to give the necessary strength. The strapping and tying of the frames is very thorough. The whole strength of the hull lies practically in the framework, but the plating of the underbody is heavy enough to give additional rigidity. In the plating, where weight of hull is not against the stability of the boat, the plates are about a quarter of an inch in thickness, but much thinner on the topsides. In *Shamrock I.* the lead casting was bolted to the bottom of the boat; in *Shamrock II.* the frames and plating of the hull were carried down to the bottom of the draught, and had the lead slung inside the bottom of the fin. This latter plan has been adopted in *Shamrock III.* The mast, gaff, and boom were of hollow steel, with strengthening lattice work inside the bowsprit of solid wood, and the lighter spars of hollow wood. The whole design has been pieced together without mark. In the fittings and general equipment every care was taken to obviate the possibility of a breakdown. All the parts were machined to render them as light and accurately fitting as possible, and were also carefully scrutinised and tested for flaws, apparent or inherent. The bobstay has been fixed and strengthened by a new and reliable method. The utmost care has been spent on the spars, and every precaution has been taken to make them rigid enough to withstand the tremendous strain of the big expanse of canvas the yacht will have to carry. The yacht is to be steered by a wheel, not by the aid of a tiller.

Cup Contests.

The coming contest will be the thirteenth attempt to wrest the cup won by the schooner *America* in 1851. Mr. James L. Ashbury was the first challenger in 1870, with the 200-ton schooner *Cambria*, built by Ratsey, of Cowes. The then defender of the Cup was Mr. Franklin Osgood's centre-board schooner *Magic*, ninety-seven tons, and the match was sailed over a course inside Sandy Hook. *Cambria* was beaten by 39 minutes 12·7 seconds. Mr. Ashbury had the schooner *Livonia* built by Ratsey in the following year, but Mr. Frank Osgood's *Columbia* twice defeated her by 27 minutes 4 seconds, and by 10 minutes 33¾ seconds respectively. At the third meeting *Livonia* won from *Columbia* by 15 minutes 10 seconds; but Mr. W. P. Douglas's *Sappho* superseded and gained a couple of races, by 33 minutes 21 seconds and by 25 minutes 27 seconds respectively. In 1876 a challenge came from Canada. Major C. Gifford's *Marchioness of Dufferin* contested with Mr. J. S. Dickerson's *Madeline*, but without success. Five years later the Canadians had another trial, when Mr. Alexander Cuthbert's *Atalanta* was defeated by Mr. J. R. Busk's *Mischief*, first to the extent of 28 minutes 20¼ seconds, and afterwards by 38 minutes 54 seconds. In 1885 Sir Richard Sutton took out the famous *Genesta*, built by Messrs. D. and W. Henderson, Glasgow. In her first meeting with Mr. J. Malcolm Forbes's *Puritan*, *Genesta* was beaten by 16 minutes 19 seconds, but on the succeeding day *Puritan* won by 1 minute 38 seconds only. Lieutenant William Henn had the *Galatea* built by Messrs. John Reid and Co., Port Glasgow, in 1886, but suffered two defeats from Mr. C. J. Paine's *Mayflower*, which won by 12 minutes 2 seconds, and by 29 minutes 9 seconds. This was followed by the West of Scotland Syndicate boat *Thistle*, designed by Mr. G. L. Watson, and built by Messrs. D. and W. Henderson. *Thistle* had *Volunteer* as opponent, and was beaten in both matches, first by 19 minutes 27¾ seconds, and again by 11 minutes 48¾ seconds. In 1893 Mr. Watson designed, and Messrs. D. and W. Henderson built, *Valkyrie II.* for Lord Dunraven, she was pitted against *Vigilant*, which won three right away, by gains of 5 minutes 48 seconds, 10 minutes 35 seconds, and 40 seconds. Lord Dunraven returned in 1895 with *Valkyrie III.* from the same designer and builders, the defending yacht being Mr. C. Oliver Iselin's *Defender*. At the first race *Defender* won by 8 minutes 49 seconds; at the second *Valkyrie* won by 48 seconds, but was disqualified on appeal for alleged fouling at the starting line; and at the third meeting Lord Dunraven sent his yacht over the line and then retired, leaving *Defender* to sail over and win the Cup. After a lapse of four years Sir Thomas Lipton appeared with *Shamrock I.*, designed by Mr. William Fife, and built by Messrs. Thornycroft and Co., London. *Shamrock I.* met Mr. Iselin's *Columbia* eleven times before the issue was settled. At the eighth meeting *Columbia* won by 10 minutes [illegible] seconds; at the ninth *Shamrock I.* carried away her topmast shortly after the start, and *Columbia*, according to agreement, went on and won; and then in a strong wind and sea, at the eleventh trial *Columbia* won by 5 minutes 17 seconds. Sir Thomas Lipton, after allowing two years to pass, again challenged with *Shamrock II.*, designed by Mr. G. L. Watson, and built by Messrs. William Denny and Brothers, Dumbarton. *Columbia* was again the defending yacht, and proved the winner in all the three matches; in the first by 1 minute 25 seconds, and in the second by 3 minutes 35 seconds. In the third *Shamrock II.* was 2 seconds ahead but lost by 41 seconds on the time allowance.

Naval Education.

During the debate on the Navy Estimates Mr. Arnold-Forster announced that the Admiralty had secured the services of Professor Ewing as Director of Naval Education, and he added that they "considered themselves fortunate in obtaining the services of one whose work at the University of Cambridge, position at the Royal Society, and high place in the esteem of all men for his scientific attainments, proved his knowledge to be so exceptional." The position is, of course, a new one. The Director will act as general adviser to the Admiralty on all educational matters, and will supervise the various naval colleges. One of his duties will be to assist in the development of the new scheme for the training of naval officers, and the importance of the engineering element in future naval training, has doubtless led to the appointment of an engineer to fill the newly-created post. We may feel assured that with Professor Ewing as permanent adviser, this aspect of naval training will, in future, be assured of the consideration to which it is entitled. A biographical sketch and portrait of Professor Ewing appeared in our April issue.

Wireless Telegraphy and Moving Trains.

Of the remarkable possibilities of wireless telegraphy as a saver of life and limb we alluded last month, when a notable instance was cited of its value to ship-wrecked mariners. Some novel experiments which are being made in America would seem to indicate that wireless messages will open up yet another method of providing for the safety of the travelling public.

On the occasion of the recent Forty-seventh Annual Convention of the American Association of General Passenger and Ticket Agents, the Grand Trunk Railway gave a demonstration of wireless telegraphy on a moving train. The experiment was entirely successful. The demonstration was made by Dr. E. Rutherford, F.R.S.C., and Dr. Howard T. Barnes, F.R.S.C., both of the Macdonald Physical Laboratory of the McGill University, Montreal. Signals were exchanged between a station and a train (which was running at the rate of fifty miles an hour). No attempt was made to cover distances comparable in length with those attained by Marconi and others, but with comparatively simple laboratory apparatus it was possible to keep the train in touch with the station for from eight to ten miles. St. Dominique was selected as the transmitting station, where two large metal plate vibrators 10 ft. by 12 ft., connected with an induction coil of the usual pattern, were situated. On the train itself the waves were received by collecting wires connected to a coherer of nickel and silver powder. The relay operated electric bells in three cars. The collecting wires were run through the guides for the train signal-cord, and extended on both sides of the coherer for about one car length. To obtain the maximum effect it would have been better to have had a long vertical wire, but since this was impossible, the horizontal wire was used. Although these were placed *inside* the steel frame cars, strong and definite signals were obtained over the distance named. Another difficulty militated against obtaining the maximum sensitiveness, as owing to the natural vibration of the train resulting from its great speed, it was impossible to have the relay adjusted to its most sensitive point. In spite of these difficulties the distance to which signals could be sent to the train was eminently satisfactory, and with more refined apparatus greater distances could, without doubt, be covered. The success of this form of wireless telegraphy, of which this was but a pioneer experiment, opens up entirely new possibilities for railway companies, and it is reported that permission has already been given to the De Forest Wireless Telegraph Company to equip the "Twentieth Century Limited" train of the New York Central system with wireless apparatus.

The Labour Problem at the Mines.

The difficulties connected with the labour problem on the Rand, were concisely stated in the inaugural address delivered to the Institution of Mining and Metallurgy by its newly-elected President, Mr. Jennings. It stated that there were in 1898 some 10,000 workers at the Rand mines, who received on an average £353 per annum. The great difficulty in white labour was the high cost of living; and, as the proportion of unskilled white labour used became greater, working expenses were largely increased, and the number of mines that could work at a profit were decreased. Against the employment of white labour were the facts —(1) That there were five million vigorous natives in South Africa who objected to extermination, required Government protection and guidance, and, therefore, should be made to take their share in the work of the country; (2) the inbred instinct of the white race against working on an equal footing with the black; and (3) that men could not be forced to run industrial enterprises at a loss, and the higher the working costs the smaller would be the tonnage exploited, and the less the total gold won. The greatest number and best quality of British colonists could be established in connection with the mines by working the greatest number of mines at a profit, employing the greatest number of skilled workmen and giving them an opportunity of earning high wages. The labour costs could be regulated by making the white men supply the brains and paying them well, but the greater proportion of the muscle must be supplied by another race, one who would be satisfied not to enter the white domain, and would cheerfully work for wages far below that required by the white population. The remedy seemed to be to apply inducements and pressure to the natives in the already tested native labour fields of South Africa, the inducements being extended in the form of money comforts, and enjoyments, and the pressure applied by making them conform more closely to the ordinary demands of civilisation in fields of work, taxation, and restraint. The recruiting area should be extended with great vigour to all accessible parts of Africa; and, as a final and last resource, and under supervision from Government, they might turn to Asia. The labour question required not only the attention of employers of labour, but also of the statesmen of South Africa; for not only was the expansion of the mining industry at stake, but on its right adjustment all industries in South Africa depended and all political difficulties and race differences were also involved.

Johannesburg Electrical Tramways.

The electrical tramway scheme of the Johannesburg Town Council has now been so far definitely settled as to admit of the issue of specifications, simultaneously in Johannesburg and London. The work will be carried out on the lines suggested in a report made by Messrs. Mordey and Dawbarn upon the whole question of electric light and power supplies. The total length of all the routes proposed at the present time as the first instalment, amounts to almost exactly twelve miles, with a double track throughout, so that the business will be one of considerable importance.

According to the programme set forth by the Council, the date for receipt of tenders in London will be May 25th for rails, tie bars, points, crossings, etc. It is expected that the orders will be placed in July and August, and that the construction will be commenced in December of this year and completed by December 31st, 1903.

Technical Education at Derby.

We have been watching with considerable interest the experiment made by Messrs. Handyside and Co., of raising the wages of their apprentices on passing examinations, and allowing ample time for the pursuit of technical education. A Derby correspondent says the enterprise has proved so successful that the local technical college is full to overflowing with eager apprentices, and it has even been necessary to form new classes. The Nottingham Technical College has issued a special circular inviting the careful consideration of employers, and quoting the arrangement made at Derby.

"The facilities with which boys can be sent to such classes must, in each case, depend upon the surrounding circumstances, and the total number employed. In large concerns, such as railway shops, where the number of apprentices would perhaps exceed the convenient capacity of the local technical institutes, it might be worth while to have a special training school in the works. In regard to the time taken for classes, this should be, if possible, in the morning, between the hours of 8 and 1. Boys attending such classes can take things more easily, and in such a way be quite fresh for the work they have to do. In most cases the work is done in the evening after the work of the day, and the result cannot be so good, as it requires much more effort to really concentrate the attention of the mind when all the muscles of the body are crying out for rest."

Ever since the old guilds disappeared, continues our correspondent, a wall of misunderstanding and coldness has grown up between employers and men. The men have formed unions, and the masters have federated. All combinations of labour should make the most of their organisation to promote and enhance greater intelligence in the younger men. English industry, balance, and reliability, combined with intellect trained to approach, attack, and surmount the increasing number of problems appearing for solution, can, and should certainly be successful in keeping pace with German and American competition.

There is no doubt at all that technical institutions are increasing in value, and will continue to prosper directly an intelligent interest is taken in all that is attempted, and a real effort made to utilise even a fraction of what is offered. The time is coming for the masters and men to approach and come together through the medium of technical education.

NOTABLE BRITISH PAPERS OF THE MONTH.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

FITTINGS THAT WEIGH DOWN BATTLESHIPS.

At the Spring Meeting of the Institution of Naval Architects, Mr. W. H. Whiting read an important paper on the effect of modern accessories on the size and cost of warships. The accessories referred to were the features which have been introduced into warships at a rapid rate during the last twenty years, but are not specifically designed for and necessary to the main object of the vessel's existence. There is a great difference as to the importance or necessity of these matters. But, as Mr. Whiting pointed out, they all have to be paid for. "The payment may be mainly in cost, or it may be—it generally is—in increased size of ship as well, and in decrease of speed or offensive power or protection." Having quoted several striking instances of the magnitude to which such fittings may attain, the author remarked :—

If one were to attempt to lay a complete list before you it might perhaps be thought that some of the items are so small that a reduction in their weight is hardly worth making. One often hears it said : "What will you save—not a hundredweight ?" Or it may be that even a smaller figure is named. But it is obvious that a small percentage on a large number of items may give quite an appreciable result ; and very often the percentage is a large one, though the absolute weight concerned is but little. Further, each saving has to be multiplied by two or three to get its gross effect on the ship. And lastly, the real question is : "What can be added by such savings to the armament, or to some other primary feature of the ship ?"

Take for example a 9,000-ton cruiser, whose hull weighs, let us say, 3,500 tons, her machinery, 1,600 tons, and her armament 700 tons. Now, supposing even that on the greater part of her hull structure proper and of her machinery no great saving is possible, yet if we can save 5 per cent. on 2,000 tons we have 100 tons, and this is 14 per cent. on the armament weights. It may be a very fair subject for inquiry whether the additional 5 per cent. of hull and machinery weights will be worth as much as the 14 per cent. of armament when the vessel goes into action. And if you go round a ship and carefully examine the weights in detail, there are a very large number on which you can conceivably save 5 per cent. There are fewer than one might at first suppose which are not capable of an economy of 5 per cent.

DESIRABILITY OF COMBINING THE MOST ADVANTAGEOUS QUALITIES IN MEN-OF-WAR.

Sometimes, of course, you can reduce the weight of fittings by more careful design alone. It needs to be made clear, however, that you cannot always do so. Such savings can only be got in many cases by sacrificing something which admittedly adds to efficiency in a minor sense. This is inevitable. You cannot get something for nothing, or, if you do, it is not worth having. Yet it is not always understood that economy in these matters often means giving up something that you want and not merely something that you do not want. It is hardly to be supposed that there will be found in a modern vessel many things that are absolutely useless.

The main question in any given design is whether there have been selected and combined the most advantageous qualities which can be got on a given displacement and for a given price at that moment. If we have it, it is a successful design. If we have materially sacrificed qualities which will certainly be needed at the beginning of an action to provide for risks which may occur at its close, or for other remote contingencies, then the presumption is that there is a more satisfactory design possible. It is often the case that those who appreciate the advantages of the little efficiencies in detail, nevertheless fail to recognise why the completed vessel compares unfavourably as to her fighting qualities with a ship from which such fittings have been more rigorously excluded.

SOME OF THE PRINCIPAL CAUSES THAT TEND TO INCREASE THE WEIGHT OF WARSHIPS.

Many causes have worked together to affect a modern warship in this way; many are still in operation: and I wish to devote my remaining time to a brief summary of those which can well be brought before this institution.

(1) The natural tendency in any large organisation is to retain things which have come to be of less use than formerly, or even of no use. From this tendency navies are not exempt, and we find fittings and stores retained which might possibly be omitted with advantage. The strong feeling in favour of the retention of sails long after these had ceased to be of use, and had even become a danger, is an illustration of this tendency.

(2) The rapid development of mechanical improvements of every kind leads to the introduction of labour-saving appliances in warships and merchant ships alike. But, whereas these are accompanied by great reductions in the crews of merchant ships, it is necessary to keep big crews in warships for fighting purposes, and thus we get on the one hand steam pumps to save daily manual pumping of fresh water or of the bilges, and on the other hand special fittings for exercising purposes.

(3) The higher standard of life ashore and afloat adds rapidly to the weights of warships. The provision for food, cooking, bath-room and sanitary fittings, ventilation and artificial light has greatly increased in the last twenty years and is still increasing. A large proportion of the complement needs superior accommodation, corresponding with their higher training. The weights of tiling and of piping for hot and cold water are vastly greater than those that served for many ships which are still in commission.

(4) The steam or electric motors used for the purposes of the last two paragraphs involve a heavy coal bill, so that to give a ship a specified steaming capacity it is necessary to add a much larger percentage of coal than formerly. This load has to be carried at the given speed.

(5) The distrust (or rather the partial trust) of new appliances adds largely to weight and cost. Candles or lamps give place to electric light, but the fear of losing the light involves the carrying of two systems instead of one. So it has been with sail and steam power, steam and hand steering, hydraulic gun gear and hand gear. And as it is but rarely that the new appliance has an advantage in every conceivable circumstance over the old there is a great tendency to carry both. In almost every case such duplication involves some new chance of a breakdown; and this serious consideration applies also to the two following paragraphs. New risks, thus introduced, have brought about many accidents in recent years.

(6) A natural desire to provide for every risk leads to great increase in detail. Thus, many vessels used to have five different methods of operating the steering gear. The anchor and cable gear, the ventilation, drainage, and pumping arrangements had and still have great elaboration. It is, of course, very difficult to so accurately appraise a particular risk as to say that it is not worth providing against. It is still less possible to provide for it without making the ship as a whole suffer to a certain definite extent.

(7) A closely allied tendency is that which leads to the duplication of fittings. Thus there are two steering engines, or two leads of shafting to operate the steam-steering engine; the dynamos are designed so that one may always be under repair or idle; and each of the hydraulic pumping engines is equal to the whole demands of the armament. Here, too, the cause of the demand for the increased weight is the difficulty of saying exactly what risk should be accepted. The logical course would be to make provision proportional to the magnitude of the risk multiplied by its probability. It is possible that in some cases an approximate valuation might be obtained by careful study, and I would like to suggest that no small service might be rendered to the Navy by an examination of this question.

(8) A great source of increased weight is the additions called for by comfort and convenience, rather than by direct necessity. Thus bigger steamboats, better artificial lighting, double or rain awnings, side screens, wind-shoots, ice machines, etc., though each of undoubted utility, and though reaching in no way beyond the standard of comfort in passenger steamers, do, nevertheless, impose a considerable load, direct and indirect on a warship.

(9) The desire, and perhaps the necessity, for smartness adds largely to weight. First and foremost in this connection comes paint. One who has not the records before him may well be incredulous at the enormous weight of paint worked into a ship. The most serious feature is that the process never ceases, and the greater the pride in the ship the greater the tendency to sink her with white lead. I have been told of a case in which there was removed, from the inner surface of a portion of the crew space of a destroyer, paint of a weight of over 2 lb. per square foot. This is, no doubt, exceptional, but I doubt whether all officers realise how, by a rigid economy in paint, they may not inappreciably benefit their ship. A curious development of this wish for smartness is the desire for screw gear on board ship. Not merely in rigging, but in many fittings, such as awnings, ridge-ropes, guard chains and ropes, and in the securing of all kinds of gear, lashings have given place to screws and slips, which not only add directly to the weight, but impose greater strains on the fittings. The screws mean bigger awnings, stanchions, and so on.

(10) Auxiliary machinery tends to be continually increased in power by the competition of fleet life. Weighing anchor, laying out anchors, and other

operations carried out in concert lead to the working of gear for all it is worth, and to demands for more power, although the direct use in war may not be great.

(11) Any doubt as to tactics, whether of defence or offence, must inevitably add to weight. Thus the torpedo net defence, now rarely carried by fast cruisers, formed a big load in earlier vessels. Similarly, questions as to the positions of search lights, the use of fighting tops and of submarine mines have had the like tendency. There is a larger sense in which this consideration affects ships. If it could be exactly and permanently determined in what way a fleet should be used, great economies in design would no doubt be possible. It might conceivably lead to greater specialisation, so that a squadron, not necessarily homogeneous as to offence or defence, should become the unit of design. The extended use of auxiliaries might tend to ease many difficulties in the design of a single fighting ship.

(12) The greater demand for perfection in fittings has led to increased weight in recent years. This applies particularly to such matters as water-tightness in skylights, ports, casings, and electrical fittings. No one who compares the fittings of two ships whose age differs by ten years or more can fail to see the additional weight of fittings due to this cause.

(13) A desire not to press machinery severely imposes a great load on a ship compared with another in which such pressing is admissible. If this consideration extends not merely to the boilers but to the many pieces of auxiliary machinery throughout the ship, the effect is very appreciable.

(14) Daily life in a ship tends to call attention far more to what is felt to be lacking than to what is redundant, and hence in a ship, as in a house, there is a constant tendency to add new fittings at a higher rate than to dispense with others.

(15) Desire for great durability may unduly increase the first cost and size of a ship. It is possible that it may pay better to accept frequent repairs than to add to scantlings and weight.

(16) The general tendency to raise important parts of the vessel in relation to the water-line makes it ever more difficult to secure adequate stability, and this involves increased dimensions. Economies tend to be made in the lower parts of the ship. Additions are more often high up.

(17) Every accident to a ship leads to demands for mechanical provision in all other ships to meet or prevent such a case, although the chance of its recurrence be small, or the accident due to personal causes.

Some of these factors exist in merchant ships, but there is one radical difference between the mercantile marine and the Navy. In the latter the test of experience is largely wanting. If from any cause there be imposed on a merchant ship unnecessary loads or superfluous cost, there is an immediate and automatic check. She does not pay. Somebody's else's ships pay better. Dividends are the touchstone of efficiency. Nothing of the kind exists in any practical shape in regard to warships. You cannot test them by setting them [illegible] poor substitute.

But, though the keenness of the competition in the case of fighting ships be less evident and its realisation be delayed, it is none the less real. Its very intensity makes these minor matters of design things of moment. It constitutes the best of reasons for saving small weights and for accepting small risks.

A QUESTION OF TIME AND MONEY.

It has sometimes been suggested that there is no harm in making a ship somewhat bigger than is necessary for the satisfaction of the main conditions of the design. The saving of small weights is looked on as unnecessary stinginess. This line of thought ignores the fact that the weight involves cost. All the arguments I have tried to lay before you are immensely strengthened when we reflect that these additional weights nearly always impose an expenditure of money in greater proportion than that of weight. Improvements are generally expensive. You make a machine 10 per cent. more costly without making it 10 per cent. heavier. You sometimes do both without making it 10 per cent. more efficient.

These objections to economy ignore also the loss of time. Given two designs, in one of which there is a marked increase in elaboration and complexity of detail, and you will increase the time of building faster than the weight or, perhaps, than the cost. Speed of construction is an important element of the naval strength of the country. It increases the available force at any moment and leaves our building resources available for fresh work. Elaboration does precisely the opposite. It takes from the primary features of each ship. It lessens the number of ships to be got for a given sum. It delays their production.

Lastly, in the ceaseless accumulation of these accessory features of warships we have one of the chief factors in their general deterioration. Their armament, armour, and machinery tend to fall behind as improvements in manufacture and design follow one another in rapid succession. This is, of course, inevitable. But nothing so surely tells against a ship as the continued process of sinking her. The history of many ships, as recorded by their draughts from year to year, affords conclusive proof that the growth of minor details amounts in the aggregate to a large variation in the principal feature of a design.

In conclusion, it was remarked that advance in the field covered by the paper was a very difficult matter.

So many things militate against economy. It is rarely a thing about which one grows enthusiastic. There is much discouragement with it, and some little risk. But the work is there, and has to be done; and it can only be done by the united efforts of all connected with the Navy. It is by no means merely a question of office design. It needs the intelligent and ceaseless co-operation of all engaged in the work of construction, and not least that of our subordinate building officers and workmen. Most of all, it needs the continuous help and often the thought and self-denial of naval officers of all ranks, who necessarily exert so great an influence on the details of the ships they have to live in and to fight.

It is well known to many here that this subject is not a novel one. It has engaged the attention of those who direct the affairs of the Navy. Much has been done; but it is a work in which much more still remains. It is with the object of attracting more general attention to the practical side of the question that this paper has been prepared.

In the course of the ensuing discussion Admiral Sir E. R. Fremantle remarked that stores had not been mentioned, but he thought that too many were now taken on board a ship. Professor Biles thought the paper important, because it really called attention to the absence of precise information as to the weights, etc., of recent warships. He pleaded for less secrecy in important particulars of design.

Vice-Admiral Sir Gerard Noel was "dead against" reducing the boats. The 18-ton boats were invaluable, not for comfort or habitability, but for service in war time. Masts were being reduced, yet they were almost essential for signalling and other purposes. But stores certainly could be reduced, as also could the amount of paint, if the dockyards would only paint the ships as the service liked them.

Sir William White heartily endorsed the main purpose of the paper, which was to interest all concerned in naval construction in carrying economies in the weight of accessories as far as possible. Naval architects asked that it might not be their business only to keep down weights. He did not wish to suggest that naval officers were not alive to this matter, but a point had been reached where it was necessary to look with the greatest care into the question of accessories. Here the co-operation of the naval officer was wanted, and he was sure the architects would get it. In the ships of war of a great service like ours there was inevitably a tendency towards greater complication and fuller equipment, involving greater weight. No naval architect wished to leave out anything essential, but as to what was essential there was a difference of opinion.

THE "LINES" OF FAST CRUISERS.

A PAPER on this subject, by Vice-Admiral C. C. P. FitzGerald, was read at the Spring Meeting of the Institution of Naval Architects, the author remarking at the outset that he dealt with the question more as an inquirer than with the idea of laying down the law dogmatically as to what are or are not the best possible lines upon which ocean cruisers of high speed ought to be built.

Both professional naval architects and professional seamen know perfectly well that it is impossible to get high speed in any vessel without fine lines, and it is equally impossible to get very high speed without very fine lines. This sounds almost like a truism to those who know anything about the subject. No amount of horse-power will avail unless the co-efficient of fineness bears a certain relation to the speed required; but it appears to me that there is a great deal of difference between fine lines and hollow lines; and this brings me directly to the point which I trust some naval architects here present will elucidate for us, viz., whether there are any special advantages in hollow lines which are not apparent to the eye of a seaman, or which can be taken as an adequate compensation for the disadvantages which he knows them to possess in all conditions of wind and weather, with the sole exception of dead smooth water—a condition which, I need scarcely say, is very rare at sea.

I may perhaps point out here what I mean by reference to the diagram (fig. 1). This diagram shows the water-line of our armoured cruisers of the "County" class, and I think it can be scarcely open to question that their lines are very hollow, particularly the bow lines. I may observe that the ships themselves look even more hollow than the diagram shows, though this, of course, may be an optical delusion.

I have ventured to add to the original diagram a dotted line showing an imaginary water-line which is not hollow, but slightly convex, and approaching more nearly to the lines of our 30-knot destroyers, and of fast Atlantic liners, and I would ask the question whether these lines would require a greater horse-power to drive them at a given speed than the hollow lines, even in smooth water? And, if this question is answered in the affirmative, I would still point out that by filling in this hollow, the ship would be given a greater displacement, and would in consequence be able to carry a greater weight of engines, and she would certainly be a better ship in rough water, even if there was a slight falling off in her trial trip speed.

I am quite aware that, generally speaking, comparisons between the designs of war cruisers and Atlantic liners are apt to be misleading, as the ships are intended to perform totally different services, and it is impossible to combine the requirements of both in any one ship. It is not necessary to enter into the details of this incompatibility, as they must be obvious to both naval architects and seamen; but there is one quality which is essential to both, and that is, length. You cannot drive a short ship against a head sea: it is simply impossible. Length is necessary in order to get anything like high speed in rough water; and, moreover, total length, or length over all, is of no use unless it is combined with length of floor; it is, in fact, actually detrimental, as it only increases the pitching moment. A comparatively broad and flat floor amidships, with two very fine and hollow ends, will only make a rocking machine, which may possibly be driven fast in smooth water, and may be suitable for a river steamer, but which is quite unsuitable for an ocean cruiser. I put forward these views on the subject as the crude remarks of a seaman, subject to the contradictions of applied science; but they are the result of many years' observation of the behaviour of ships and vessels of various classes, in all conditions of wind and weather, and they must be taken for whatever they are considered worth.

In comparing the lines of our larger ocean war cruisers with those of destroyers, it is obvious that in the latter the proportion of length to breadth is greater than in the former, thus admitting of finer lines, and this length is no doubt necessary in order to get space for boilers enough to produce the great horse-power required to drive these little vessels at 30 knots; but in examining the drawings of destroyers, and in looking at the vessels themselves, I am unable to see any hollowness in their lines. The lines appear to be almost quite straight, and in some boats slightly convex, until you get aft as far as the boiler space; and yet these little vessels (putting on one side some signs of structural weakness) have proved themselves to be splendid sea boats for their size, weathering Atlantic gales and typhoons in the China seas.

TANK EXPERIMENTS.

I desire to speak with the greatest respect of tank experiments. I have not the smallest doubt that they have been of great use to naval architects in elucidating problems in hydrodynamics, and in assisting them to come to conclusions as to the form of model which offers the least resistance at various speeds. Such experiments and researches must always be useful in checking theory with practice, so far as such trials can be considered practical; though it must be borne in mind that all tank experiments relate only to smooth water conditions, and it is quite possible that the conclusions arrived at through a combination of abstract theory and tank experiments with small models may be misleading, if applied too rigidly to full-sized ships which have to travel upon the troubled surface of the ocean. Indeed, it is impossible to help surmising that tank experiments are responsible for the hollow lines of which I am now speaking. If I am wrong in this surmise, I shall, no doubt, be corrected.

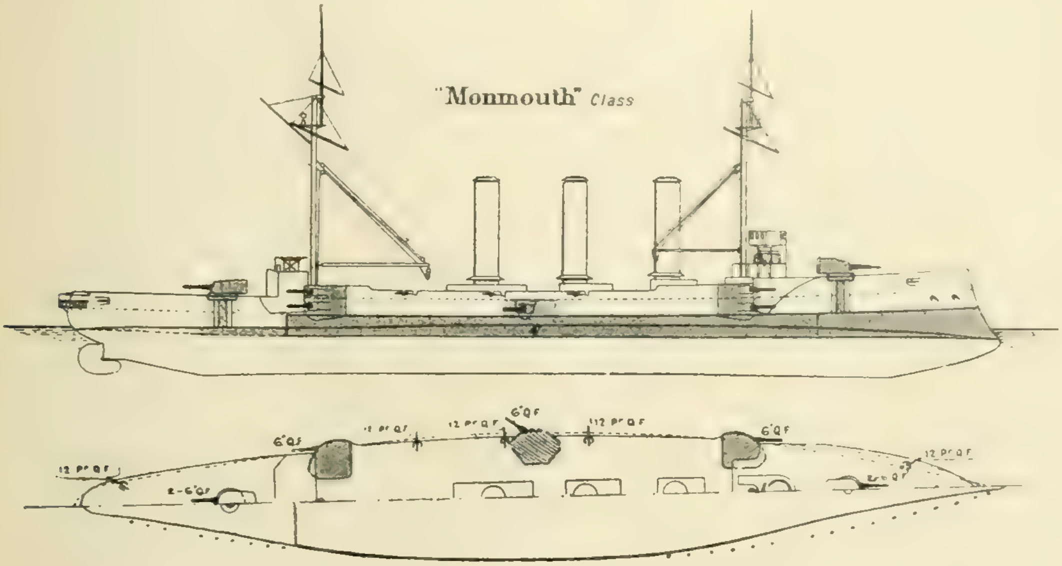

FIG. 1.

Some years ago we used to hear a good deal about the "wave line" theory; in other words, a hollow bow. Speaking from memory, I think it was introduced—or, at any rate, advocated—by the late Mr. Scott Russell; but I have certainly been of opinion that this theory has since been discredited, both by naval architects and seamen, for all ocean-going steamers, although it is possible that it may still be applied with success to river steamers: at any rate, it is certain that you will not see a hollow line in any of our fast Atlantic liners. Splendid models of these ships are on view in many public places particularly in Cockspur Street, so that anyone can see for himself that there is no hollow in the bow lines; but that, on the contrary, the floor of the ship is carried right forward to the cutwater—a form which enables the vessel to rise to a sea, instead of pitching deeply into it.

A COMPARISON.

It has often been urged that comparisons between British and foreign cruisers are apt to be misleading, and unfair to the former unless the full particulars are known and set forth. This, no doubt, is perfectly true; but yet, in spite of the very high authority by which this warning has been issued, I think it will not be irrelevant to the present subject to compare the British *Kent* of the "County" class with the Russian cruiser *Bayan*, built at La Seyne. The *Kent* has a nominal tonnage of 9,800, the *Bayan* 7,800, and there can be no doubt that the additional 2,000 tons ought to give a great superiority to the *Kent* either in speed, armour, armament, or coal endurance. With regard to armour, there does not appear much to choose between them, although the distribution of it is quite different; thus the *Kent* has a belt 4 in. thick amidships, tapering to 2 in. forward, carried right to the stem; and the *Bayan* has a belt 8 in. thick amidships (but very narrow and short at this thickness) tapering to 3 in. forward, and carried right to the stem. In both cases the belt stops about 100 ft. from the stern. The *Kent* has a 5-in. bulkhead; but I cannot find out whether the *Bayan* has or has not a bulkhead. The width of the thin belt in both ships is about the same.

The *Bayan* is armed with two 8-in. guns, protected with 7-in. armour; eight 6-in., protected with 3-in. armour; twenty 2·9 in., eight of which are behind 3-in. armour; and seven 1·8-in. guns. The *Kent* carries fourteen 6-in. guns, protected by 5-in. and 4-in. armour, and thirteen 12-pounders unprotected; her armoured deck is 2¾ in. thick, against the *Bayan's* 2 in., and the *Kent* carries more ammunition than the *Bayan*; but the latter has two submerged torpedo tubes, and the *Kent* has none. With regard to coal supply, the *Kent* carries 800 normal and 1,600 full stowage for 22,000 h.p. engines, and the *Bayan* carries 750 normal and 1,100 full stowage for 16,500 h.p. engines.

The *Bayan* was designed for 21 knots, and made 22 on her trial. The *Kent* was designed for 23 knots, and made 21·7 on her first trial; and, although she has somewhat improved upon that, owing to some alteration in her screws, she has not yet attained her designed speed; nor have any of her sisters. Presumably the *Bayan's* trial lasted for only three hours, and the *Kent's* for eight. The *Bayan* is 445 ft. long by 57 ft. beam, and the *Kent* is 440 ft. long by 66 ft. beam. The 5 ft. additional length, coupled with 9 ft. less beam, commends itself to the mind of a seaman as being a better form than the other one for driving against a head sea; and it seems to be no worse for attaining a good trial trip speed. I have not been able to get the lines of the *Bayan*. It is difficult to get the lines of foreign ships; but I have seen a good many French-built ships, and I can safely say that I have never been able to detect a hollow line in any of them.

In the above comparison I have endeavoured to be perfectly fair, and have impartially given such information as I have been able to collect; and it certainly does not appear as if our "County" class of 9,800 tons possess such a superiority over the *Bayan* of 7,800 tons as they ought to possess. It would be interesting to know if this is in any way attributable to their hollow lines.

CONCLUSION.

It is always rash to prophesy, and yet I will venture to predict that the whole of our "County" class will prove to be very wet ships. They will be wet for two reasons: one is that their sponsons are too low, and the other is that they have hollow lines, particularly the bow lines; and this, in combination with the armour carried right forward to the stem, will make them pitch with all the venom of much shorter ships; and it must be remembered that a wet ship interferes considerably with the accuracy of gun fire.

THE PREMIUM SYSTEM.

MR. JAMES ROWAN, in the course of a paper read before the Institution of Mechanical Engineers, has contributed some useful hints on the premium system as applied to engineering workshops. The author's experience of the system described has been gained in the manufacture of marine engines, but it can be applied by any manufacturer.

PRELIMINARY RECOMMENDATIONS.

Before deciding to introduce the premium system it is recommended that the following points be well considered, viz.:—

The amount of personal work involved, the prospective expenditure of capital, the perseverance required on the part of the management to maintain it, and the initial outlay on the rate-fixing department. It is only by the most assiduous attention and the utmost perseverance that it will be successfully carried through. It should never be allowed to be a failure. It would be better not to attempt it if there is any chance of failure, and it certainly should not be introduced into any workshop hurriedly or before arrangements are thoroughly made.

RATE-FIXING DEPARTMENT.

The first thing to be done by a firm introducing a premium system is to establish a rate-fixing department. It is of importance that a separate department be started, and that the rate-fixing be not placed as an additional duty upon the foremen. No one need be alarmed at this, as two men will do all the rate-fixing that is required in an engineering workshop employing about 300 men. In a very short time the rate-fixing, timekeeping, and wages-costing departments will merge into one, as the work done is so much allied. Two men, with the assistance of two timekeepers and two boys, will do all the work that is required, until the wages are abstracted and invoiced against the different jobs. The man in charge of the rate-fixing department should be a trained engineer, with a good deal of workshop experience and some experience in the drawing office. An intelligent man, with this training, soon gains the confidence of the workmen, and in a short time is able to fix time allowances with wonderful accuracy, and his practical experience is of great assistance.

COLLECTING DATA.

It is essential to have data as to the times taken by the men at the various jobs when working on time wages, before the premium system can be introduced into any workshop, and the following hints may be useful. Let it be assumed that the workshop has been working on time, and that the times to do the various operations have been taken in detail by the timekeepers or recorded in some manner by the men themselves, as is done in many workshops, or where the work is large, such as marine engines, electric-light engines, etc., that the times to do all the operations have been recorded against the contract as a whole. It may be considered [illegible] that the times as thus taken by their timekeepers, or recorded by the men, afford them sufficient information to start upon. Too much value, however, should not be attached to these times, and they should not be used as a basis for fixing time allowances.

Data should be gathered systematically and with great care. The gathering of data at the introduction of the premium system is in itself one of the most interesting, instructive, and valuable parts in the programme. An intelligent, well-educated engineer should, at the outset, assist the rate-fixer when gathering data, by standing by a few machines from starting-time in the morning till stopping-time at night and noting the elements of each operation. He should be given "Job Tickets" or "Lines," fig. 1, for the jobs the machines are employed upon, on each of which the rate-fixer should have written the time of starting and the details of the operation. When the jobs are finished, the engineer will initial and write on the lines the time finished, and return them to the rate-fixing department for recording.

The elements of an operation include the time for lifting an article on to the machine, for setting, for grinding tools, for machining, the speeds and feeds, the dimensions of the surfaces machined, the time taken to remove the job from the machine to the floor, etc., and also delays of every description and the

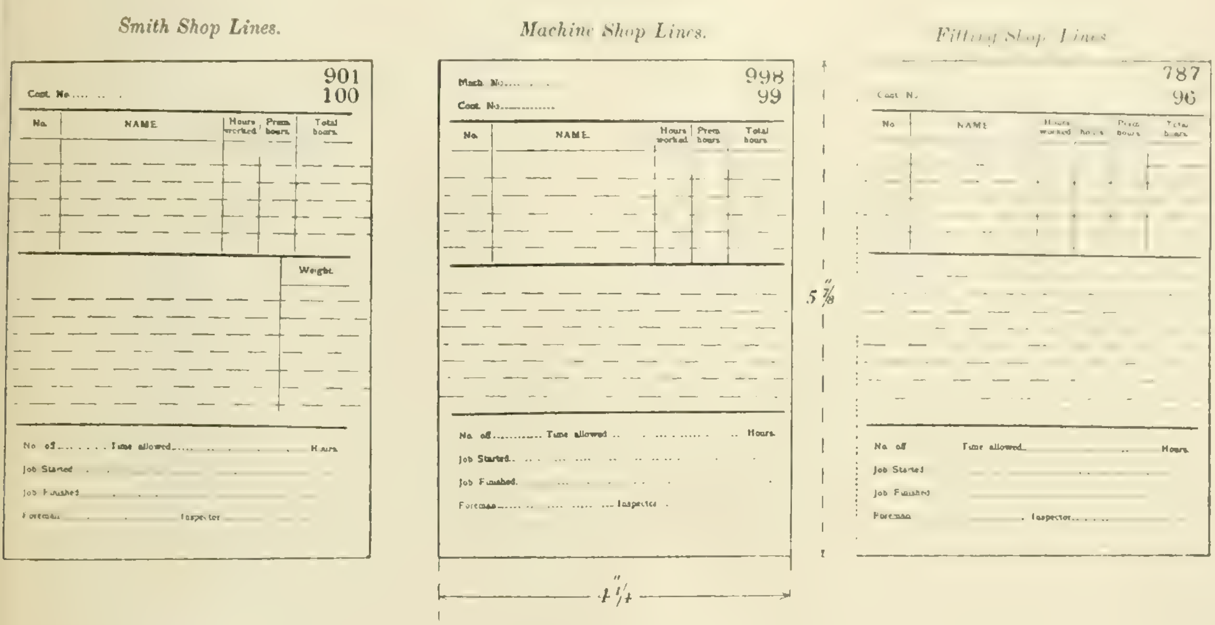

FIG. 1.

reasons for them. This information if properly gathered is very useful although later on it becomes valueless. These particulars, as well as the time each man at a machine takes to do his job when working on an hourly rate of wages should be carefully recorded by the rate-fixer in a book prepared for the purpose. A fair average time can thus be arrived at in which a man can do a piece of work, when working on time, and this can be fixed as the time to be allowed for duplicate jobs in the future, and used as a basis for fixing the times to be allowed for jobs of the same nature but larger or smaller.

Another method is to base the allowances on the best recorded or estimated performances, and add such percentage as may be considered proper.

TIME ALLOWANCES.

In a workshop with about 150 machines, three men should gather all the data required, in from two to three months. Standard times may also, in the same manner, be arranged for work that is common in all workshops, such as drilling holes, tapping holes and inserting studs, machining flanges, etc. These times can only be accurately arrived at by personal and constant attention to the machines where this class of work is being done, but once the standard times are arranged, a time allowance can very quickly be arrived at for similar jobs, the times being arranged at so many holes per hour and so many minutes per diameter of flange, etc. It may be discovered by these observers that the time which is being taken to do a piece of work is excessive, and this should be carefully investigated before fixing a time allowance, as it may be caused in many ways apart altogether from the workmen. The usual method of the workshop may be a bad one. Feeds or speeds may be bad. It may be due to want of proper tools, or to the machine being out of repair, or too light. Very often it is due to the want of jigs, fixtures, or handy appliances or other causes. Were it done in a new and a good machine with proper appliances, it would be apparent to everyone that it could be done in much less time. The best way of fixing time allowance for jobs, under the above conditions, is to assume the work is being done in the best machine in the workshop, and then to add a certain percentage to the time allowed on account of its being done in an inferior machine.

It has been the author's experience that in most cases the time taken to do any piece of work can be reduced, although it may require capital expenditure, together with the assistance of education and intelligence. This is, of course, common knowledge, but it may be questioned if the best use is made of this knowledge, except in workshops where a number of machines are employed in doing identically the same class of work. No doubt, in these workshops great attention is concentrated on the machines, with the result that their output is good; but where the machines are employed doing a variety of work, as in the manufacture of large engines, it is very hard to tell whether the time taken to do the work is good or bad. If, however, the time taken to do the work is down in black and white, and repeated again and again, the management should ultimately have no difficulty in deciding whether the work is done in good time or not. In estimating time allowances, after the system has been working for a period, there is nothing so useful as a comparison of the times allowed for similar jobs, and there is no question as to the value of this comparison, more especially in jobs which require considerable setting and some degree of skill and intelligence on the part of the workmen, and where the time the machine is cutting is only a minor part of the time actually required for the job. Data accumulate very quickly, and soon, no matter what job comes along, the rate-fixer can estimate a suitable time allowance for it, which will be fair both to employer and workmen.

In the process of establishing time allowances, errors may be made, and it may be found necessary to either shorten or lengthen the times first tried, and every precaution should be taken to avoid the necessity for such changes by fixing time allowances as carefully as possible. It is also essential for success that anyone adopting the premium system should deal in all fairness when fixing time allowances.

In the paper read at the Engineering Congress in September, 1901, it is stated that the payment of premium does not take effect until 5 per cent. premium has been earned, and thereafter by increments of 5 per cent. This has been found by the author's firm to be a mistake, as the men watched that the time they took to do their jobs came out at an even 5 per cent., that is 30, 35, 40 per cent. and so on. They might save 31, 36 or 41 per cent. of the time, but it was noticed that they never saved 34, 39 or 44 per cent. of the time, the reason being that by spending three or four hours more on their jobs they made a bigger premium. When they could not make 5 per cent, more, they spent three or four hours extra on their jobs until the time for the next even 5 per cent. was up.

THE SYSTEM SUBSTITUTED FOR PIECEWORK.

Again, if the firm proposing to introduce the premium system has been working piecework, the time allowances should be fixed on such a basis that the men when put on the premium system will be able right away to earn a premium. It will often be found that the time under the premium system will be reduced as compared with the time taken when working piecework, and that the man's earnings will be increased. The author can only quote one case—and it is personally known to him—where the premium system has been instituted to take the place of piecework. This is a large firm which has been working on piecework for many years; they stopped it and went on time for two months, when they introduced the premium system, and the work is now nearly all done in less time. The men are making better wages, and not a man has left the employment owing to the change from piecework to the premium system.

INFORMATION FOR WORKMEN.

Every firm introducing the premium system should issue a pamphlet to their workmen. The statement which follows will suit the requirements of most engineering establishments, but as one firm differs from another in manufacture, in district, and in many circumstances, it should be carefully studied by those issuing it.

Naturally, with such a radical change in the payment of wages as is involved by the introduction of the premium system, the workmen are disposed to look upon it with suspicion and resent it. This is a common experience where it has been introduced, and when in America last summer the author found, even there, some firms which were anxious to introduce a premium system but could not do so owing to the attitude taken up by the men. Explanations such as are given in the pamphlet will no doubt remove from the minds of reasonable workmen their principal objections to the premium system. There will always, however, remain a few who will argue that the introduction of the premium system will be the means of keeping a number of men idle, but it has been experienced from time immemorial, that the cheaper an article can be produced the greater will be the demand for it, and the number of men employed producing it will be increased.

NOTES.

The following notes are based on the pamphlet which Messrs. Barr and Stroud, of Glasgow (who were, as far as the author knew, the first to do so), issued to their workmen when they introduced the premium system into their works.

For the information of the Employees of Messrs. . . . .
regarding the Premium System of Wage Earning.

The premium system may be briefly described thus :—

Each man is paid a regular hourly rate of wages. When a job is given out, a certain time is allowed for it. If the job is completed in less time than the time allowed, the workman becomes entitled to a premium, varying in amount with the time saved. If the job takes longer than the time allowed, the workman gets paid his regular hourly rate of wages, so that, no matter how short a time may be allowed for a job, the hourly rate of wages, at least, will be paid while engaged on that job, thereby preventing a premium on one job being lost through failure to make a premium on another. It will be evident from the above that, while the workman may increase his wages, he cannot lose money by the introduction of the system.

The system possesses two main advantages :—

(*a*) It enables a workman to increase his wages by his own individual effort, and the increase is immediately added to his wages, the premium being paid to the workman each pay-day along with his wages.

(*b*) [illegible] employer.

[illegible] the same relation to the ordinary wages due for the time taken to complete an operation, as the time saved bears to the time allowed. For instance, suppose a man is allowed 16 hours to do a job and does it in 12 hours he saves $\frac{4}{16}$ of the time allowed, that is 25 per cent., and accordingly his wages will be increased by 25 per cent. for the time worked ; that is, if the rate of pay is 8d. per hour the man will receive 8s. as time wages for the 12 hours worked, and the premium earned will be 2s. (equal to 25 per cent. of the 8s.). The time wages and premium will thus amount to 10s. for the 12 hours worked.

(To be continued.)

WRECK RAISING IN THE THAMES.

THE subject of raising sunken vessels in the Thames was dealt with in an extremely interesting manner by Mr. D. W. Noakes, in the course of a lecture delivered before the Institute of Marine Engineers. Incidentally, he gave the following account of the raising of the steamer *Cora Maria*, which sank in the fairway in Sea Reach after collision and was totally submerged :—

The *Cora Maria* was 235 ft. long, 31 ft. broad and 18 ft. deep, her registered tonnage being 1,231 tons, and at the time of collision she had 1,700 tons of coal on board. She sank in seven fathoms low water ordinary spring tides, and lay on her beam ends. The first operation of slinging consisted of sweeping a small chain under the vessel. The slightest angle of deviation of the wreck from the set of the tide caused a scouring action to take place at the two ends, and usually the two ends of a vessel were free, even if the river bed were fairly good. The small chain having been swept under the wreck, a larger chain was attached, and by hauling the chain to and fro room was made to take a yet larger chain, and at last a steel wire hawser. These steel wire hawsers were specially made by Messrs. Bullivant and Co., a common size used being 8 in. in circumference, and consisting of six strands, each of thirty-seven wires. These wire ropes had proved an inestimable boon to the wreck-raiser, being infinitely more reliable than chain, which has a nasty habit of kinking. The difference in weight was also another very favourable factor, Bullivant's special salvage rope being only one-tenth the weight of chain of equal strength. Having been successful in introducing the wire sling under, say, the fore end of the wreck, the steam lighters, each carrying one end over their davits, were hauled along in the direction of the ship's length, and the wire sling was thus worked along the bottom of the vessel, the object being to place twelve lifting wires equi-distant along the ship's length. The best positions for these wire slings were controlled by such factors as length of ship, position of engine-room, nature of cargo, etc. The *Cora Maria* was successfully slung with six wires forward and six aft, all in good positions well along the ship. The vessel being slung from the pontoons by means of the twelve wire ropes, one of three things would occur before the flowing tide made its high water mark: Either the lighters must sink, the wires break, or the wreck be lifted from the river bottom. The wreck lay on her beam ends, her port side on the ground, and it was easy to see that a very severe strain would fall on the port or under side bulwark, where the wire led in a vertical direction to the pontoons at the surface. Slowly, but surely, the lighters pinned down, and then suddenly the port bulwark gave, and a tremendous noise reverberated through the craft, the lighter on that side jumping up a couple of feet. That occurrence, expected as it always is, was regrettable. Not only was the lift lost on one lighter, but an extra burden was thrown upon the companion lighter and its wires, and there existed also a very great danger that where the wires had cut through the bulwarks either the rags on the bulwarks or the sharp edge of the stringer plate might have partially cut the wires and weakened them to a dangerous degree. It was not legitimate strain that one feared, but the unseen shears below. However, everything held, and soon there was a cry "We swing." Three tugs attending, the whole flotilla was allowed to drift toward the Mucking Light, where the *Cora Maria* took the ground, and the next morning they got their first view of the wreck. The ship was now well out of the fairway, and operations were commenced for righting her. A shield was then fitted over the gash, she was pumped out, and the wreck, floating by her own buoyancy, was towed into shallower water and beached. The *Cora Maria* was ultimately sold for £1,350, proving that sometimes the wreck when salved was a valuable asset.

COMING EVENTS: MAY—JUNE, 1903.

May.

1st.—Institution of Junior Engineers: Paper—"The Effect of Design on Methods of Construction, from a Contractor's Point of View," by Mr. R. W. Newman, M.I.M.E.

2nd.—Birmingham Association of Mechanical Engineers: Paper.

4th.—Society of Arts: Paper No. 2, by Mr. W. B. Beaumont.—Society of Engineers: Ordinary Meeting at 7.30 p.m.

5th.—Society of Arts: Meeting of the Colonial Section, at 7.30 p.m.

6th.—Society of Arts: Ordinary Meeting.

7th.—Civil and Mechanical Engineers' Society: Paper—"The Choice of Steam Boilers," by Mr. C. E. Stromeyer, M.I.C.E., at 8 p.m.—Iron and Steel Institute: Annual Meeting at the Institution of Civil Engineers, Great George Street, Westminster, at 10.30 a.m.—Reception at the Institute of Painters in Water Colours, Piccadilly, at 9.30 p.m.

8th.—Iron and Steel Institute: Annual Meeting at the Institution of Civil Engineers at 10.30 a.m.—Annual Dinner of the Institute, Hotel Cecil, at 7 p.m.

9th.—Birmingham Association of Mechanical Engineers: Saturday afternoon Visit to Messrs. Mitchell and Butler's.—North-East Coast Institution of Engineers and Shipbuilders: Graduates' Meeting at Newcastle.

11th.—Society of Arts: Paper No. 3, by Mr. W. B. Beaumont.

13th.—Society of Arts: Ordinary Meeting.

14th.—Institution of Electrical Engineers: Meeting at Society of Arts at 8 p.m.—Society of Arts: Meeting of the Indian Section.

18th.—Society of Arts: Paper No. 4, by Mr. W. B. Beaumont.—North-East Coast Institution of Engineers and Shipbuilders: Council Meeting at Newcastle.

19th.—Society of Arts: Meeting of Applied Arts Section.

20th.—Society of Arts: Ordinary Meeting.

22nd.—North-East Coast Institution of Engineers and Shipbuilders: General (Closing) Meeting at Newcastle.

27th.—Society of Arts: Ordinary Meeting.

28th.—Institution of Electrical Engineers: General Meeting at the Society of Arts.

June.

6th.—Birmingham Association of Mechanical Engineers: Half-yearly Meeting and Social.

SOME RECENT PUBLICATIONS.*

"REPORT ON THE ENGINEERING TRADES OF SOUTH AFRICA."

By Ben. H. Morgan. With numerous tables, appendices, and reproductions of special plans, drawings, and photographs. P. S. King and Son. 199 pp.

SPECIALLY commissioned by the South Africa Trade Committee to proceed to South Africa, and within a period of three months report on the engineering trades there, Mr. Morgan may be said to have been engaged in fierce conflict with Time. In spite of the limitations imposed upon him, however, he has succeeded in producing a very interesting volume, and one which cannot fail to be of service in drawing the attention of our manufacturers to the South African market, while at the same time it will provide them with much useful data.

The commissioner emphasises the fact that the report represents not so much his own views as the consensus of opinion of the largest buyers and users of machinery in South Africa. We are glad to note that Mr. Morgan is authorised to say that in future no difficulty whatever will be placed in the way of any British firm desiring to tender for South African Government work, provided the usual guarantees are forthcoming as to workmanship, material, delivery, etc. A sanguine view is taken of the coming demand in our new colonies for up-to-date machinery. English goods are everywhere preferred, but complaint is made of the want of enterprising endeavour by British firms to obtain orders. They are advised to study the especial design of machinery for export, to avoid faulty packing, to extend their advertising and to improve their catalogues. There are also other hints which may be cordially recommended to those who are seeking an extension of South African trade.

Given the same amount of attention to the "get-up" and packing of goods for South Africa that other countries pay, Great Britain will not only long continue to occupy the premier position, but will far outdistance all competitors. British goods will have the preference because they are "home" goods, and because, as a rule, they are better value than most of the goods of other countries.

"SUBJECT LIST OF WORKS ON GENERAL SCIENCE, PHYSICS, SOUND, MUSIC, LIGHT, MICROSCOPY, AND PHILOSOPHICAL INSTRUMENTS IN THE LIBRARY OF THE PATENTS OFFICE."

Printed for His Majesty's Stationery Office by Darling and Son, Ltd. Published at the Patent Office. 184 pp. 6d.

A PIECE of bibliographical work which has been carefully carried out and offers a complete subject index to nearly two thousand works, representing some 9,281 volumes. The List consists of two parts—(*a*) A general alphabet of subject headings, with entries in chronological order, of the works arranged under these headings; (*b*) a key, or summary of these headings shown in class order. The catalogue entries relating to these works number 2,069 and are distributed under 196 headings and sub-headings.

"FORM OF MODEL GENERAL CONDITIONS."

Recommended for use in connection with contracts for plant, mains, and apparatus for electricity works. London: E. and F. N. Spon, Ltd. New York: Spon and Chamberlain. 1903. 1s.

WE have received from the Institution of Electrical Engineers a copy of "The Form of Model General Conditions," as above, drafted by the specially appointed committee, and presented to the Council for adoption. Copies can be had from the publishers or at the offices of the Institution.

"THE SECRETARY'S ASSISTANT AND CORRESPONDENT'S GUIDE."

21st Edition. Whittaker and Co.

IN a modernised and cheaper form this handy little book of 120 pages appears with a complete index, and makes a further bid for popularity. Its chief aim is to give the correct modes of superscription, commencement, and conclusion of letters addressed to persons of every degree of rank.

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* *A number of book notices are held over on account of pressure on our space.*

NEW CATALOGUES.

Herbert Morris and Bastert, Ltd., Empress Works, Loughborough. — "Book 28" is a neat little 32-page pamphlet of excellent design, illustrating and describing the firm's principal specialities, including Overhead Runways, Improved Pulley Blocks of many kinds, Overhead Travelling Cranes, etc. These runways are so designed (being fitted with ball bearings) that they require very little power to move, even when very heavy weights are dependent therefrom, and we are informed that a lad can travel a ton 300 ft. a minute by hand.

The Horsfall Destructor Company, Ltd., Lord Street Works, Leeds. List No. 2. A booklet of 56 pages and cover containing reports and certificates from many City Corporations, District Councils, Boroughs, etc., where the Horsfall Destructor is in use, including Pembroke (county Dublin), Stockton-on-Tees, Salisbury Sewage Works, West Hartlepool Electricity Works, Fulham Electricity Works, Accrington Electricity Works, Huddersfield Sewage Works, etc., etc.

Andrew Handyside and Co., Ltd., Britannia Ironworks, Derby. — A 38-page brochure of exquisite design, printed on one side only (in two colours), contains some excellent woodcuts and line blocks, illustrating the various designs in Smith's Hearths and general smithy fittings which are manufactured by the firm, including plan of smithy rectangular, circular and other hearths, portable forge, tools and accessories, together with price lists. Illustrations of bridges, roofs and structures (work erected by the firm) also appear, as well as some pretty designs in ornamental cast iron vases and fountains. A useful telegraphic code for incoming and outgoing messages is given on page 5.

The Wilfley Ore Concentrator Syndicate, Ltd., 7-11, Moorgate Street, London, E.C.—A neat little booklet of 38 pages and cover, containing a short treatise on the Wilfley Table (with illustrations), also some useful notes on Ore Dressing, and exhaustive instructions for erecting and operating the Wilfley Concentrating Table. The Wilfley Table, we are told, will separate minerals, etc., within a smaller difference of specific gravity than any other concentrator at present on the market; but, like all other machines of a similar character, its action is fundamentally dependent upon the difference in weight of the particles treated. In this connection appears a useful table of specific gravities for metals, metallic minerals, non-metallic minerals, etc. Users of this table include a long list of some 120 Mining Companies in all parts of the world, amongst which might be mentioned the Anaconda Copper Mining Company, Mont., where alone 431 Wilfleys are at work.

The Lyle Company, Ltd., Harrison Street, Gray's Inn Road, W.C.—Catalogue No. 3 is an excellent little brochure of 40 pages with embossed cover, printed throughout in a peculiarly attractive green tint, and containing some very fine half-tone illustrations of the Lyle Dossier System of Vertical Filing. To do it justice the system requires a somewhat lengthy description (which is not possible in this necessarily brief notice), and we must perforce content ourselves by recommending all intending purchasers of office furniture to get a copy of this catalogue and peruse it before coming to a final decision in the matter of the system to be adopted.

The Cambridge Scientific Instrument Company, Ltd., of Cambridge, England.—"The Measurement of Temperature by Electrical means." This is a 44-page illustrated booklet, containing a treatise on the above subject, from which, in order to give the reader a slight idea of the author's line of conduct, we quote the following:—

"English manufacturers are beginning to realise the importance of accurate measurements in all industrial operations. As competition increases this need for accuracy is making itself felt more keenly every day, especially in engineering and its allied trades.

A few years ago the temperature of a retort or furnace was gauged by the eye of the most experienced workman in the firm. When this particular individual left, the whole of the works were, for the time being, paralysed.

"We must use the pyrometer more freely than we do now in order to be able to determine the proper temperature at which to anneal and to temper, and to produce the same results uniformly at all times." Following this is a price list of the principal manufactures of the Cambridge Scientific Instrument Company—including Temperature Indicators of various kinds, Resistance Thermometers (capable of measuring temperatures up to 700 deg. C. (1,292 deg. F.)), Switchboards, Galvanometers, etc. At the end of the book appears a short description of Rosenhain's Improved form of Thomson Coal Calorimeter, with the aid of which, we are informed, a determination of calorific value can be made in little more than half an hour.

Ernest Scott and Mountain, Ltd., Close Works, Newcastle-on-Tyne.—On the point of going to press we have received from this firm a series of illustrated pamphlets and price lists dealing with the following specialities:—

No. 4a of two-pole dynamos, class T.
No. 5a of two-pole motors, class T.
No. 8a of four-pole dynamos, class F.
No. 9a of four-pole motors, class F.
No. 14a of multipolar generators, class M.
No. 17a of multipolar motors, class M.
No. 18a of vertical enclosed compound central valve high-speed engines.
No. 22a of compound enclosed central valve steam engines and direct coupled generators.
No. 26 of multipolar generators for direct coupling.
No. 27 of horizontal compound enclosed engines and crank shaft generators.
No. 28 of three crank compound engines and direct coupled dynamos.
No. 29 of double cylinder high-pressure enclosed high-speed engines.
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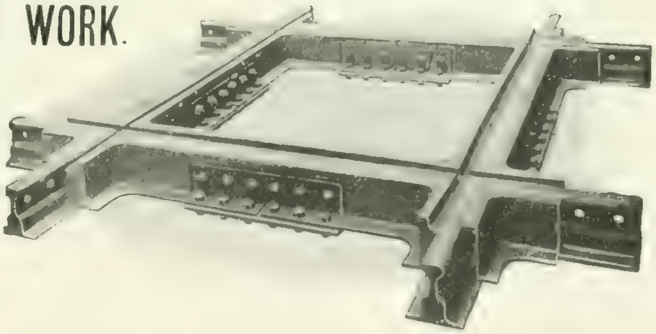

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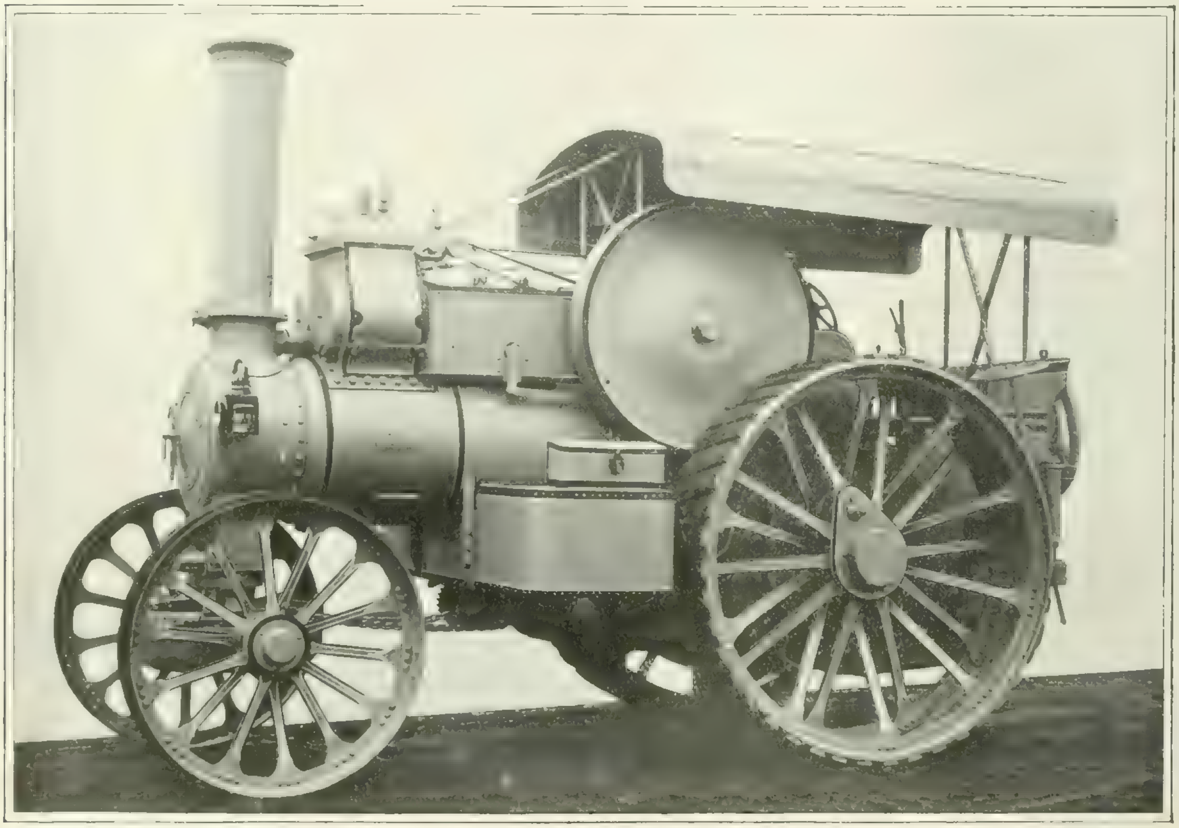

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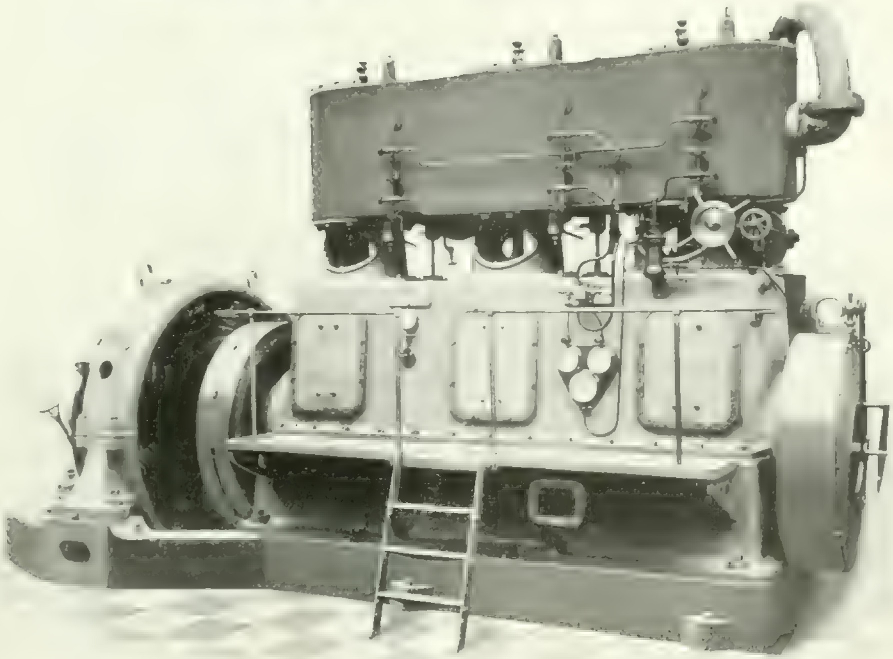

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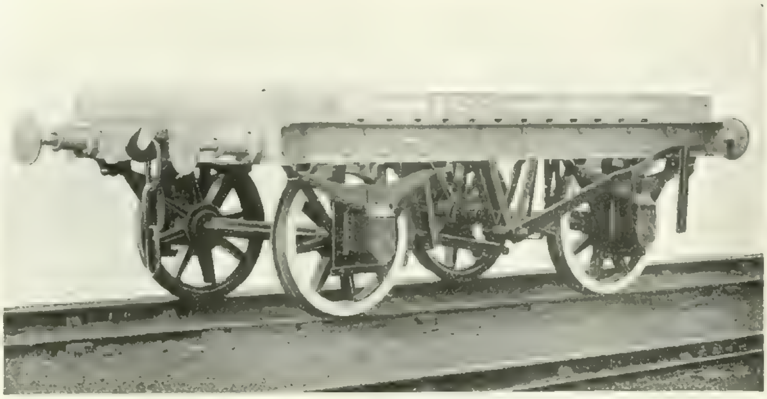

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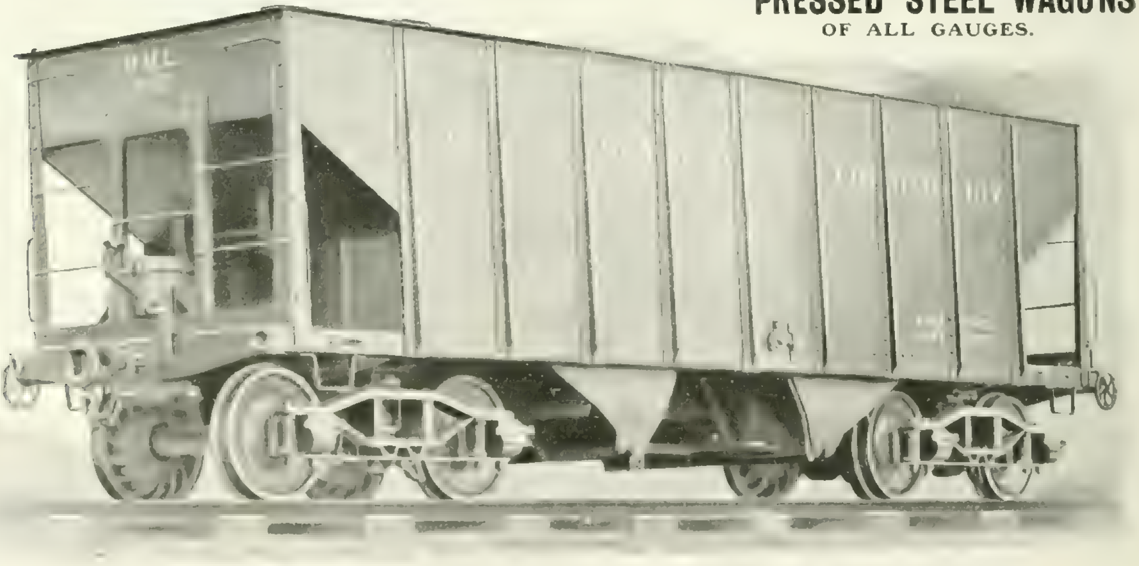

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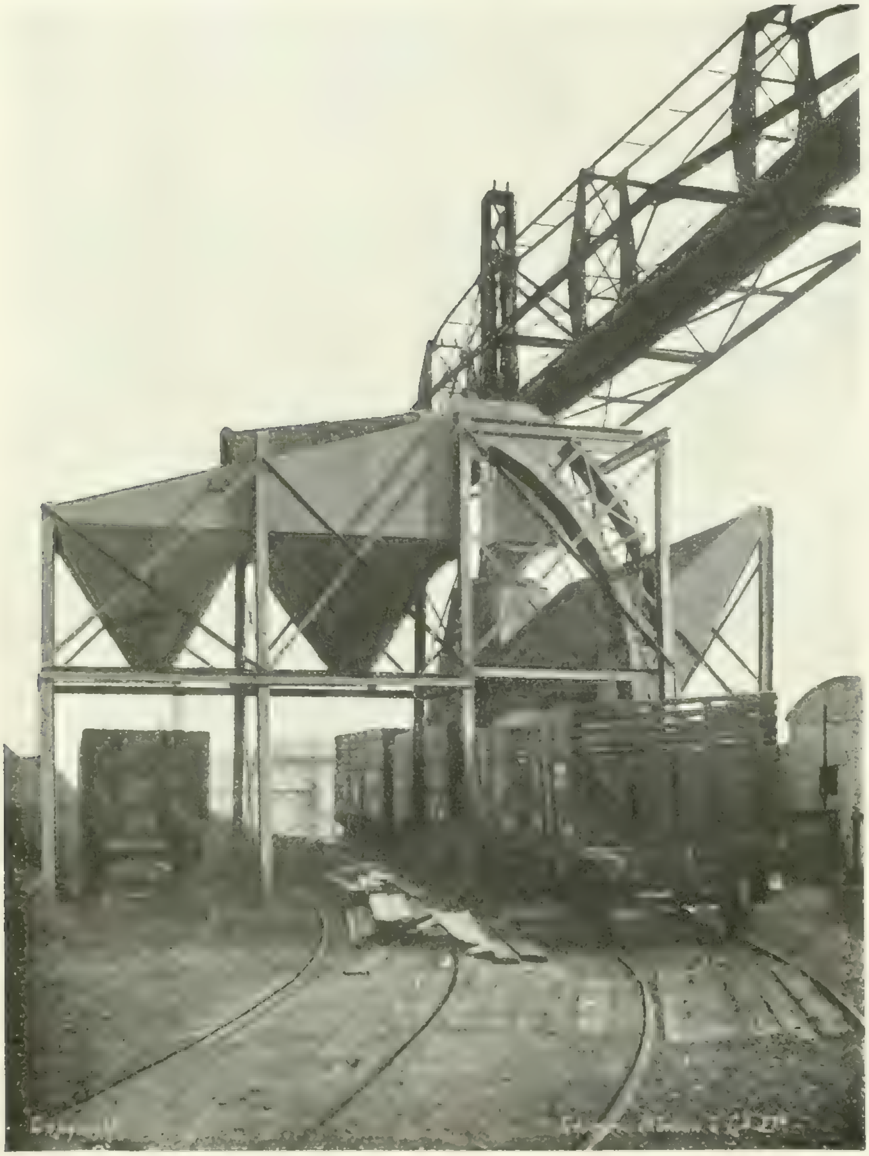

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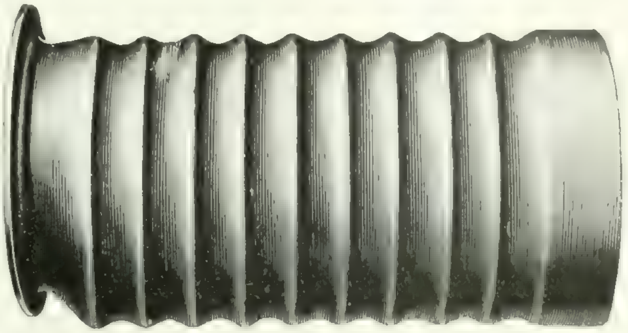

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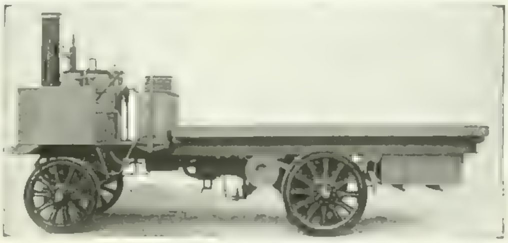

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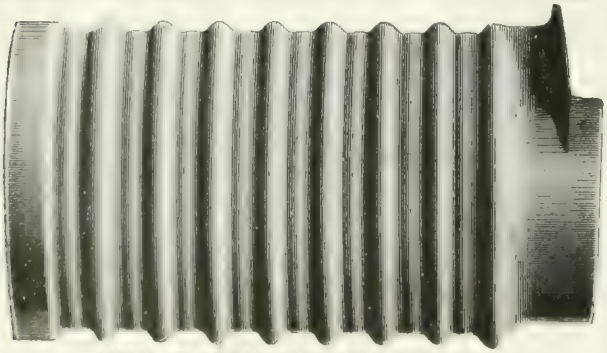

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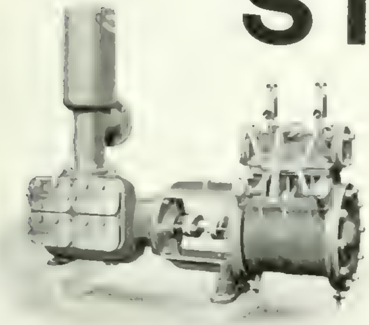

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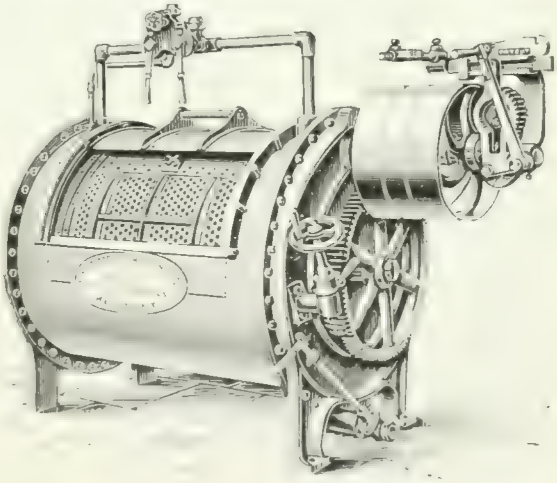

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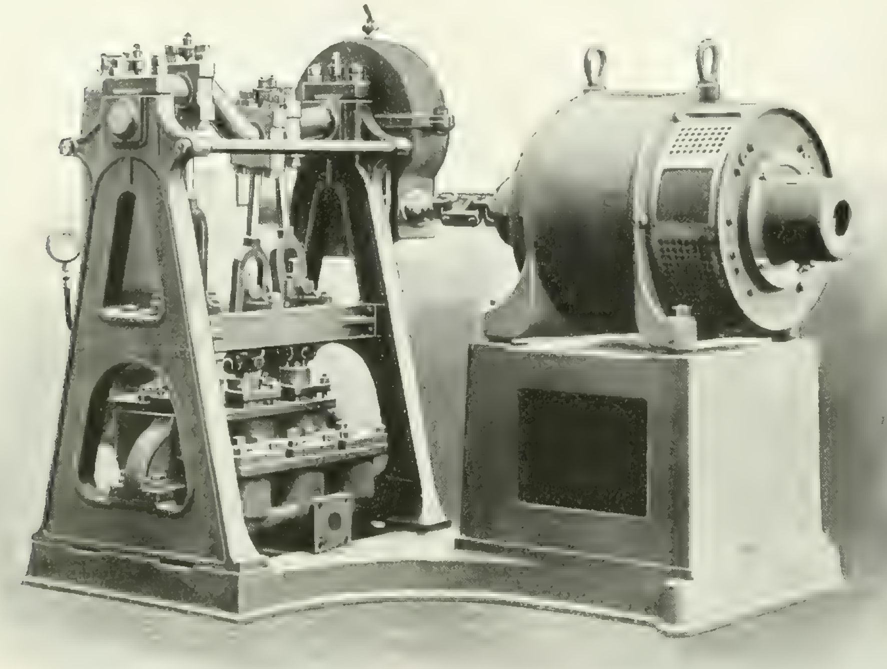

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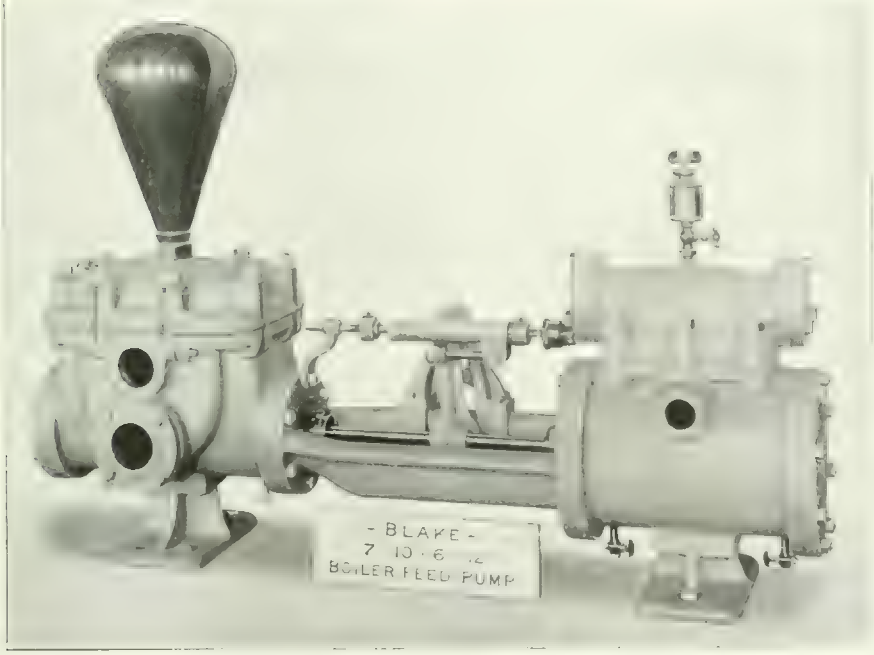

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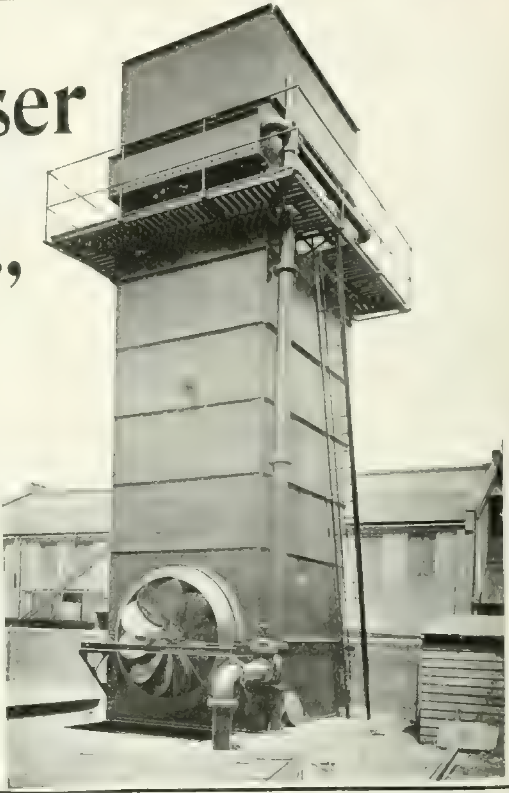

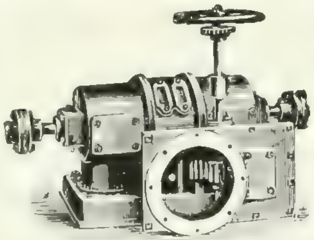

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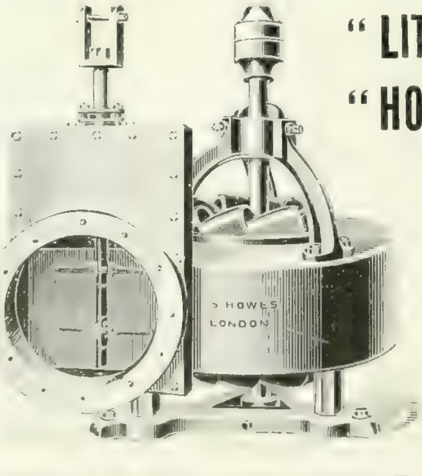

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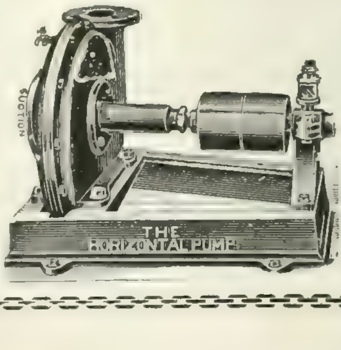

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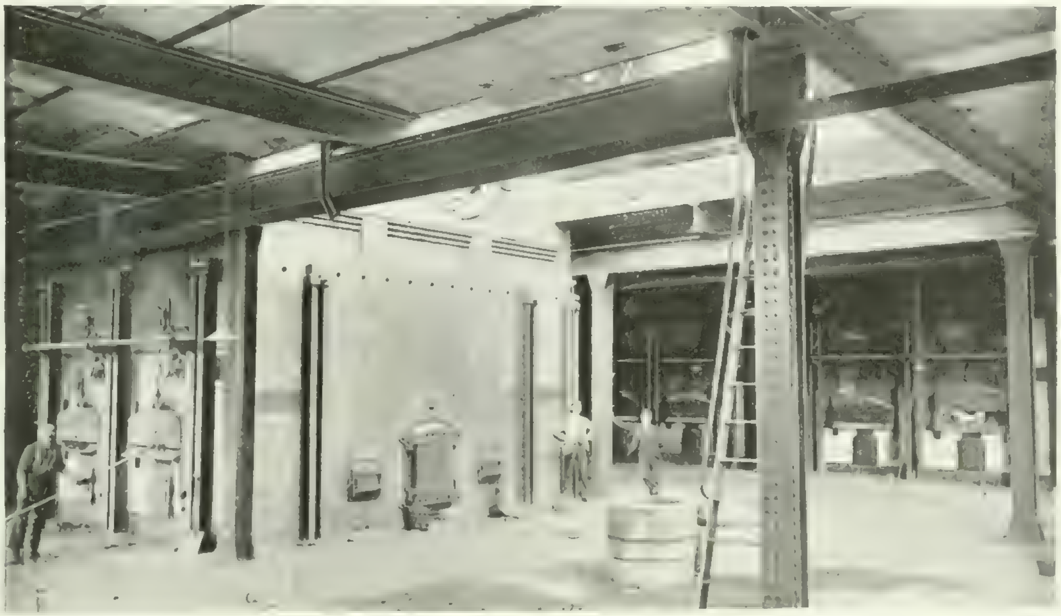

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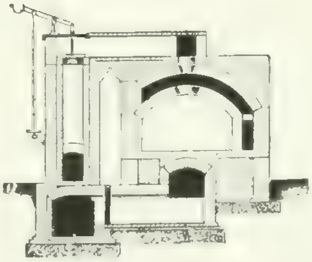

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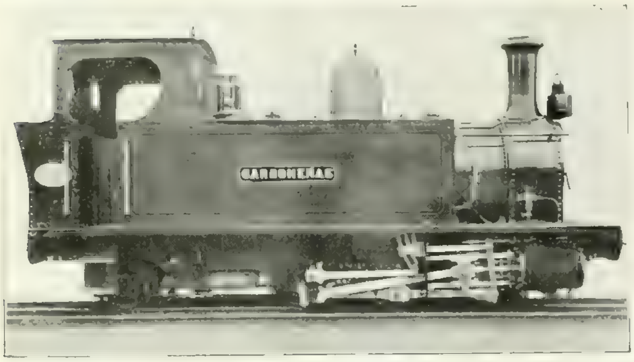

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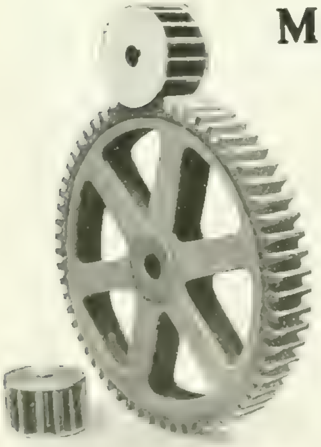

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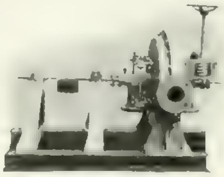

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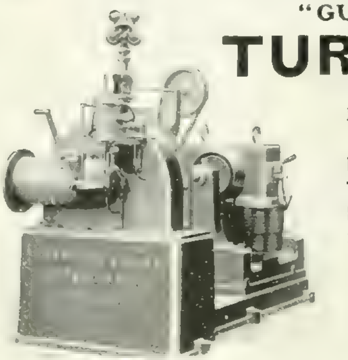

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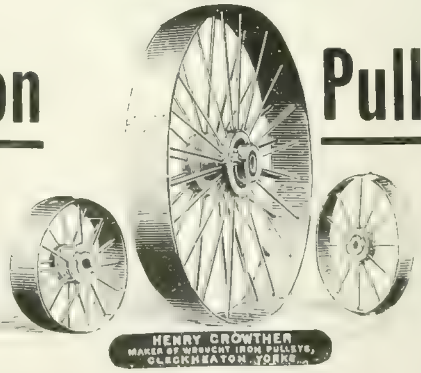

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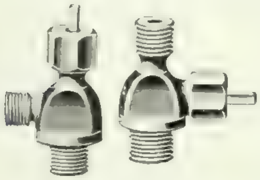

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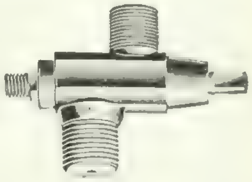

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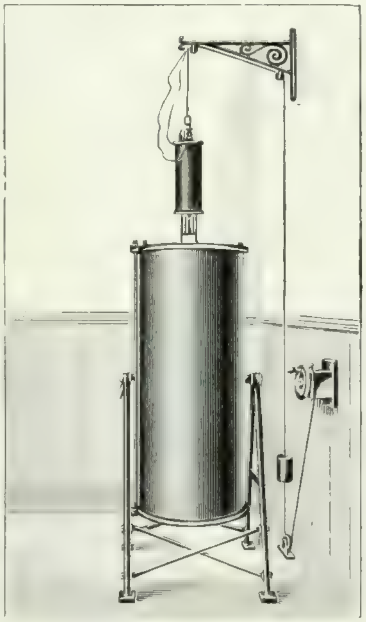

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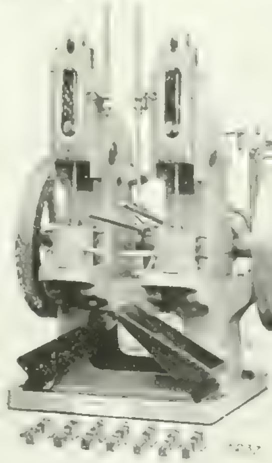

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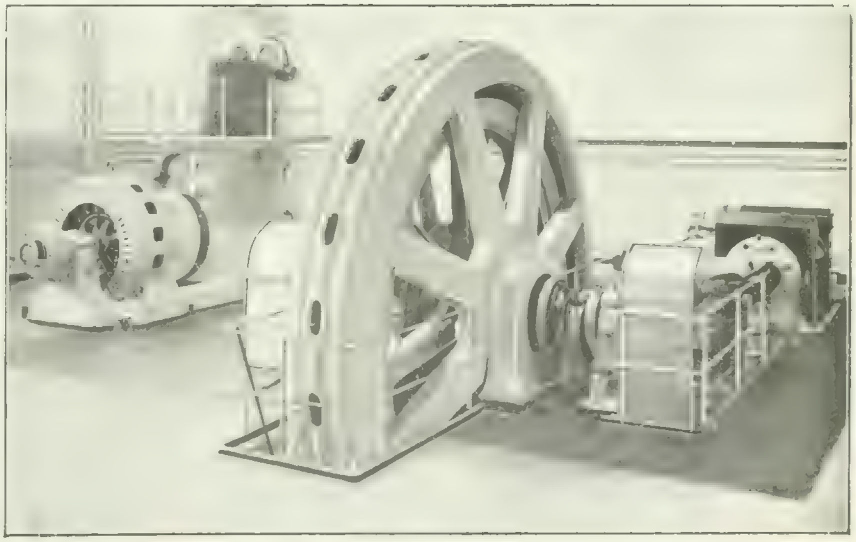

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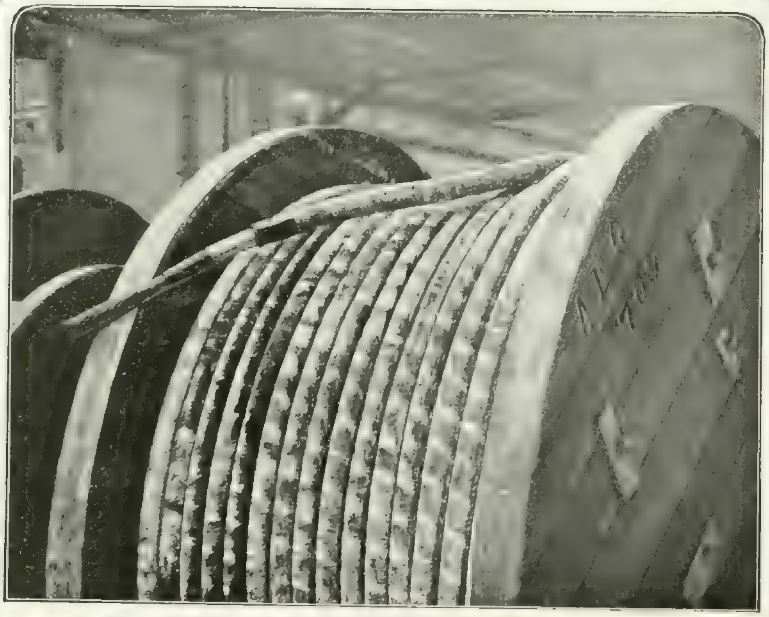

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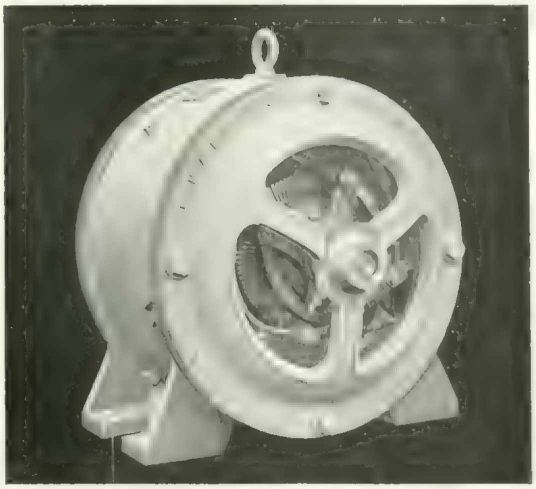

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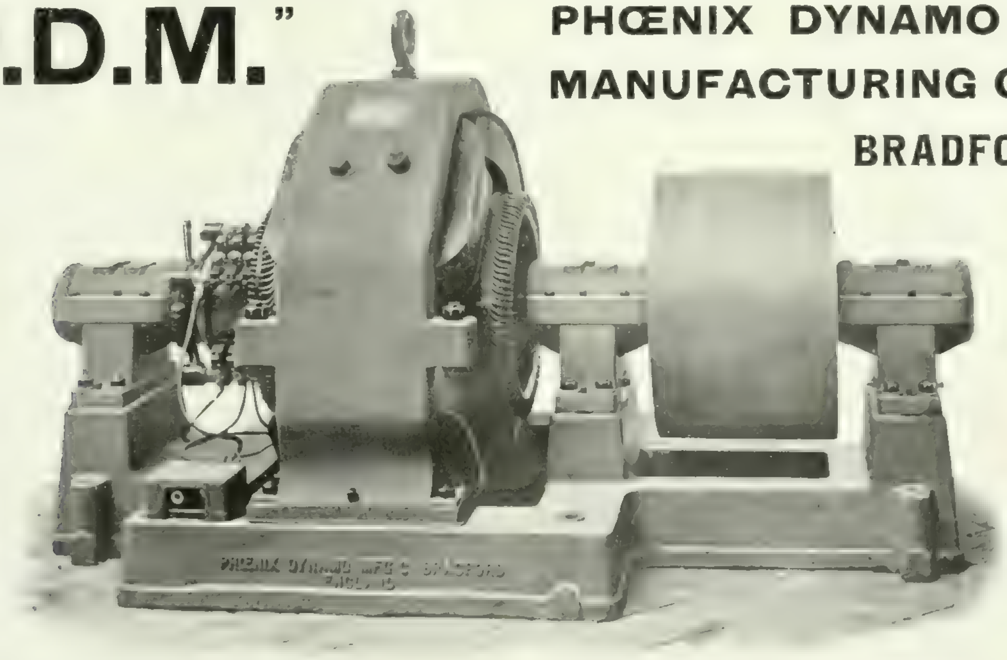

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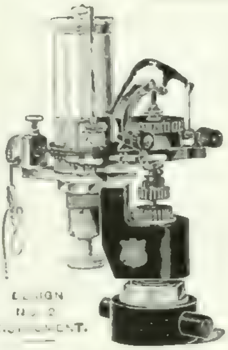

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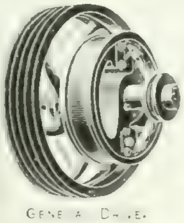

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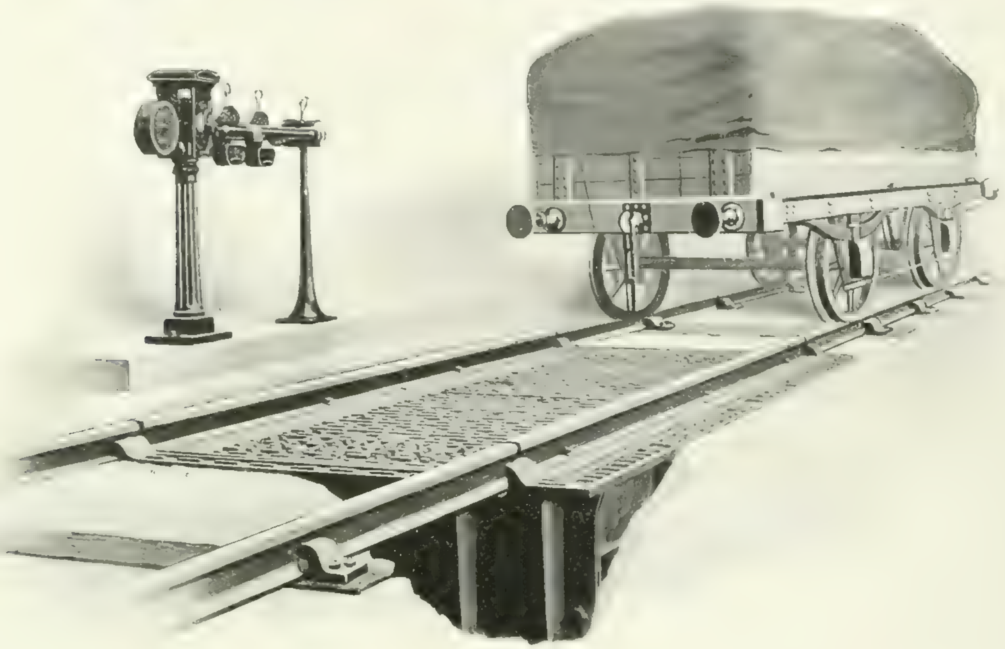

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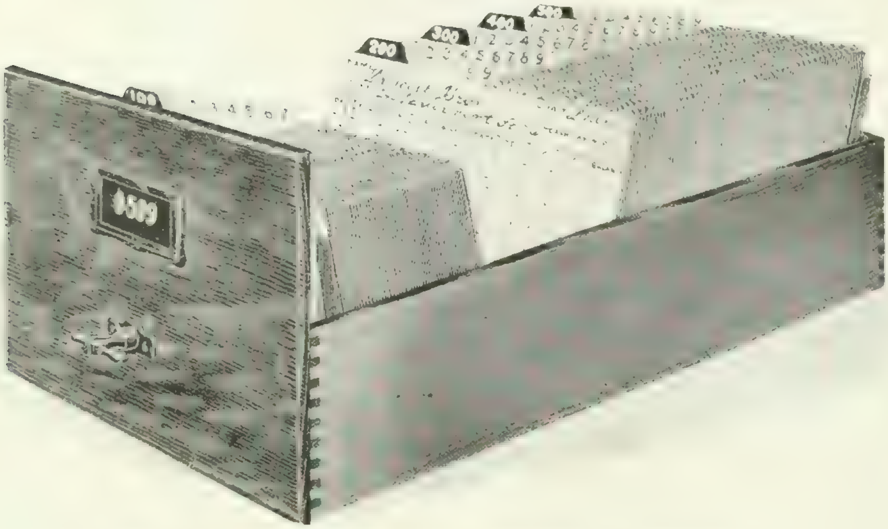

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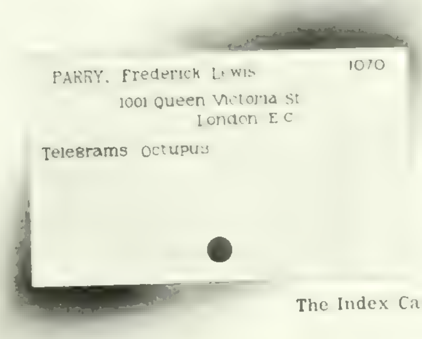

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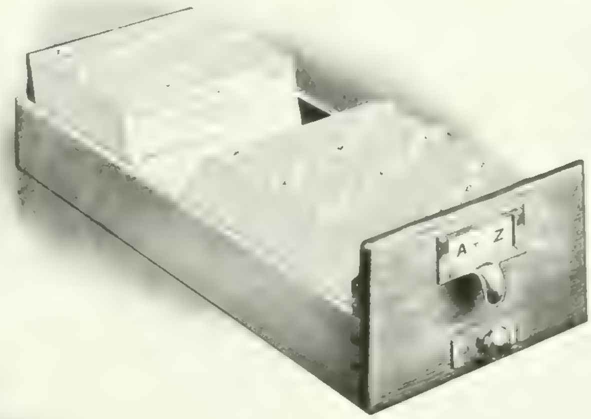

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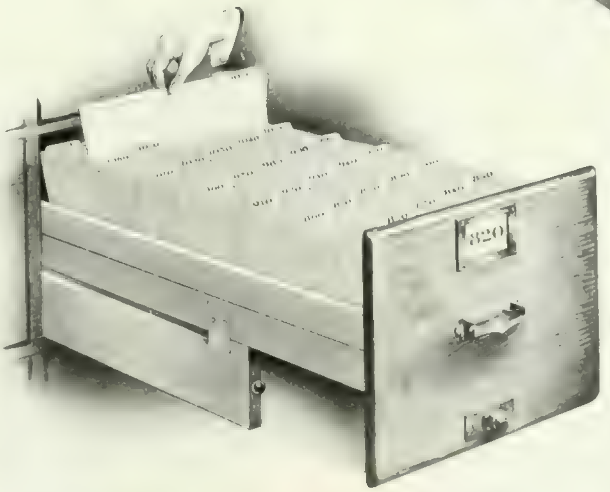

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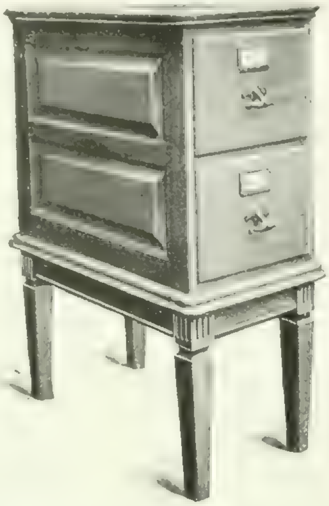

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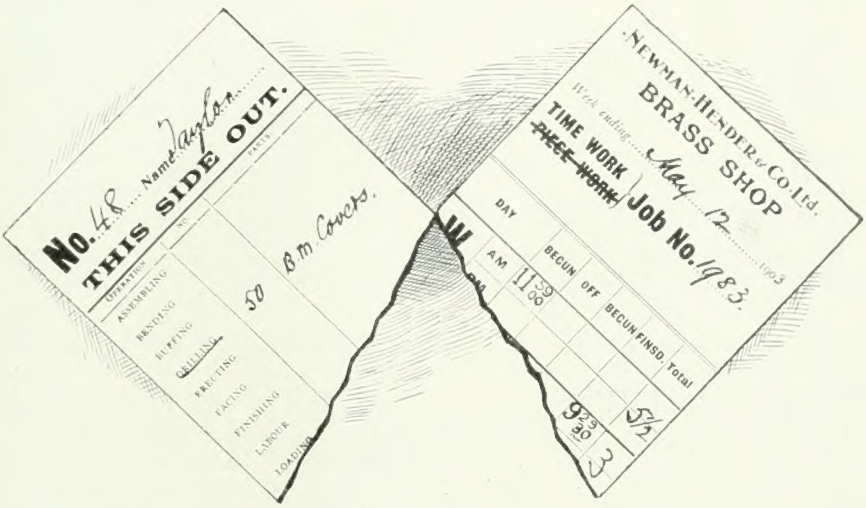

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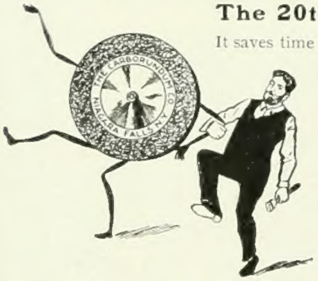
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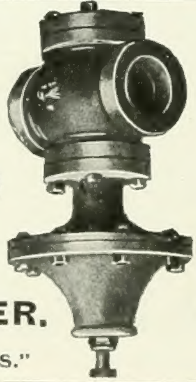

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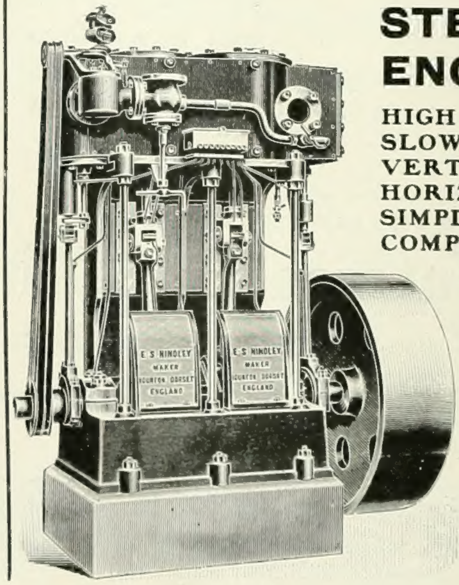
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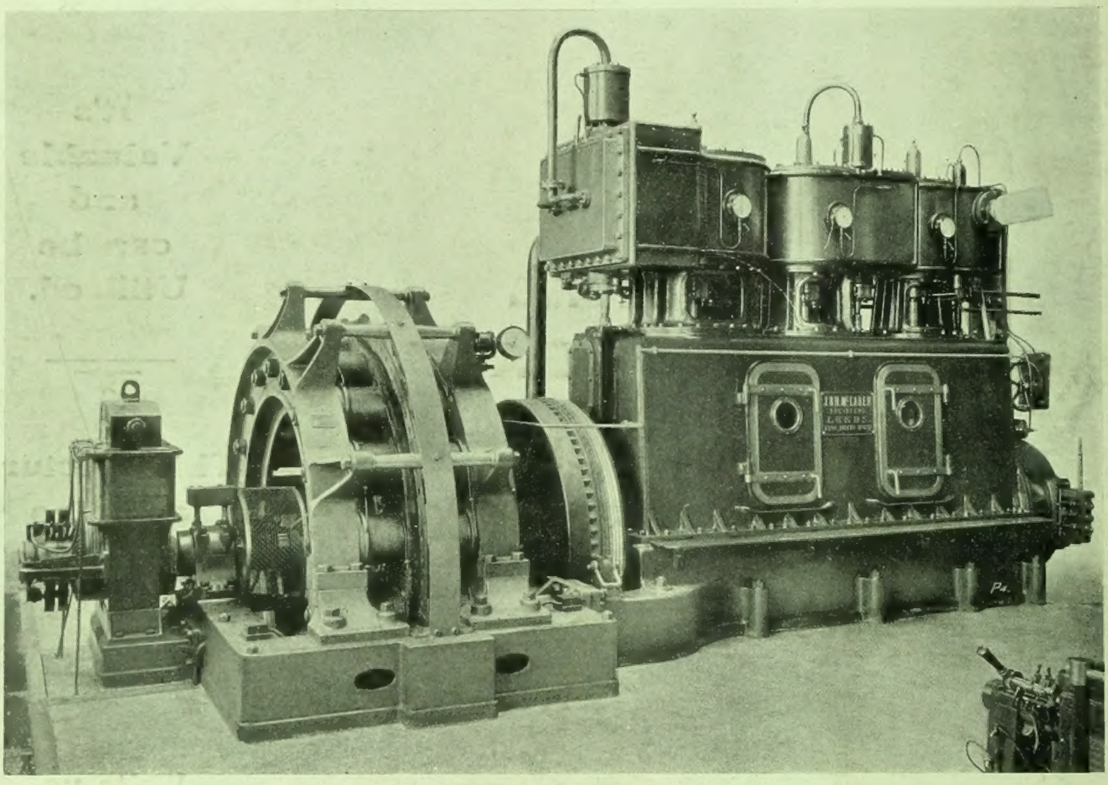

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